Desktop Engineering®

DECEMBER 2009 • VOL. 15, ISSUE 4 • $9.00

TECHNOLOGY FOR DESIGN ENGINEERING

DESKENG.COM

Annual Awards Issue!

Change the World Challenge Awards

—2009—

Companies Changing the World

> Design
- Autodesk
- SolidWorks

> Simulation
- ANSYS
- COMSOL
- SIMULIA

> Rapid Technologies
- 3D Systems
- Geomagic
- Materialise
- Solido
- Z Corporation

> IT/Computing
- Intel
- National Instruments

"The process of product development is really accelerated by having the MDX-540. It has allowed me to cost effectively make parts I wouldn't previously consider attainable. The machine's precision is incredible. Its versatility and accuracy are outstanding."

JOE MATTEO
MicroTypes, LLC

CAN YOUR 3D PRINTER DO THIS?

GLASS-TEFLON GUIDE PLATE
Milled on the MDX-540 from glass-filled Teflon providing mechanical strength and heat resistance up to 300° C.

LEXAN PLATE
Cut in outline mode, leaving top and bottom faces polished.

Systems starting under $8,000 US

MDX-540 shown

Subtractive Rapid Prototyping Gets Microscale Medical Applications to Market Quickly and Cost-Effectively

Joe Matteo, founder of MicroTypes, LLC, relies on the Roland MDX-540 to produce precision components for high-tech instruments used in medicine and science. The instruments contain micro-scale parts with features as small as 75 microns, approximately the thickness of a human hair. These components need to operate under high heat and pressure conditions which require precision fabrication on a range of diverse materials including aluminum, Lexan™, Delrin™, Teflon™ and PEEK. The accuracy of the MDX-540 allows Matteo to create prototype parts with a fit and finish so precise they can be used in laboratory experiments and medical diagnostic tests. The MDX's versatility means he can produce a part from various substrates, and then test them at high temperature, pressure, and even high vacuum conditions to see which materials and designs perform best. With the MDX-540, he is able to run more design iteration cycles with valuable performance testing in less time than other rapid prototyping technologies, reducing development costs while bringing better products to market. Can your 3D printer do that?

Imagine. Roland®

FOR MORE INFORMATION OR A DEALER NEAR YOU, CALL 800-542-2307 OR VISIT WWW.ROLANDDGA.COM/SRP

CERTIFIED ISO 9001: 2008

Where Do I Go for Data Acquisition Products?
omega.com, of Course!

Go to: www.omega.com/dilbert for your daily dose of DILBERT!

iServer MicroServer™
Connect Any Serial Device to an Ethernet LAN and the Internet

Starts at $195

EIT-W

MADE IN USA

Quickly configured through a Web browser

Embedded PC Board Assembly for OEMs Consult Sales for Pricing

EIT-D

Visit omega.com/eit-w

Non-Contact Infrared Temperature Sensor with Wireless Transmitter

Starts at $285

UWIR-2-NEMA

IR sensor head.

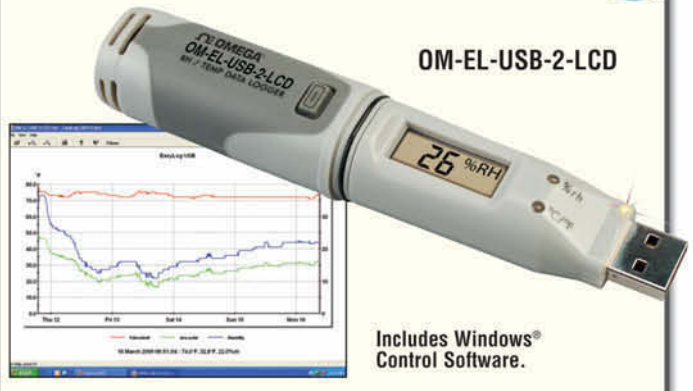
Visit omega.com/uwir-2

MADE IN USA

Temperature, Humidity and Dew Point Data Logger with LCD Display

Starts at $97

OM-EL-USB-2-LCD



Includes Windows® Control Software.

Visit omega.com/om-el-usb-2-lcd

Miniature RFID Data Loggers and Readers Feature Economical, Fast, Accurate Wireless Data Retrieval and Storage

Starts at $90 5 per pack

The Mini NOMAD® Series
OM-84-TMP

Features a miniature, water resistant NEMA design and a factory replaceable battery.

Visit omega.com

*PATENT PENDING

MADE IN USA

Your single source for process measurement and control products!

For Sales and Service, Call TOLL FREE
1-888-82-66342®
1-888-TC-OMEGA

Direct Link:
omega.com/909DK3

*PATENTED
Covered by U.S. and International patents and pending applications

Shop Online at
omega.com®
OMEGA®

Sustainable Minds Release 1.0

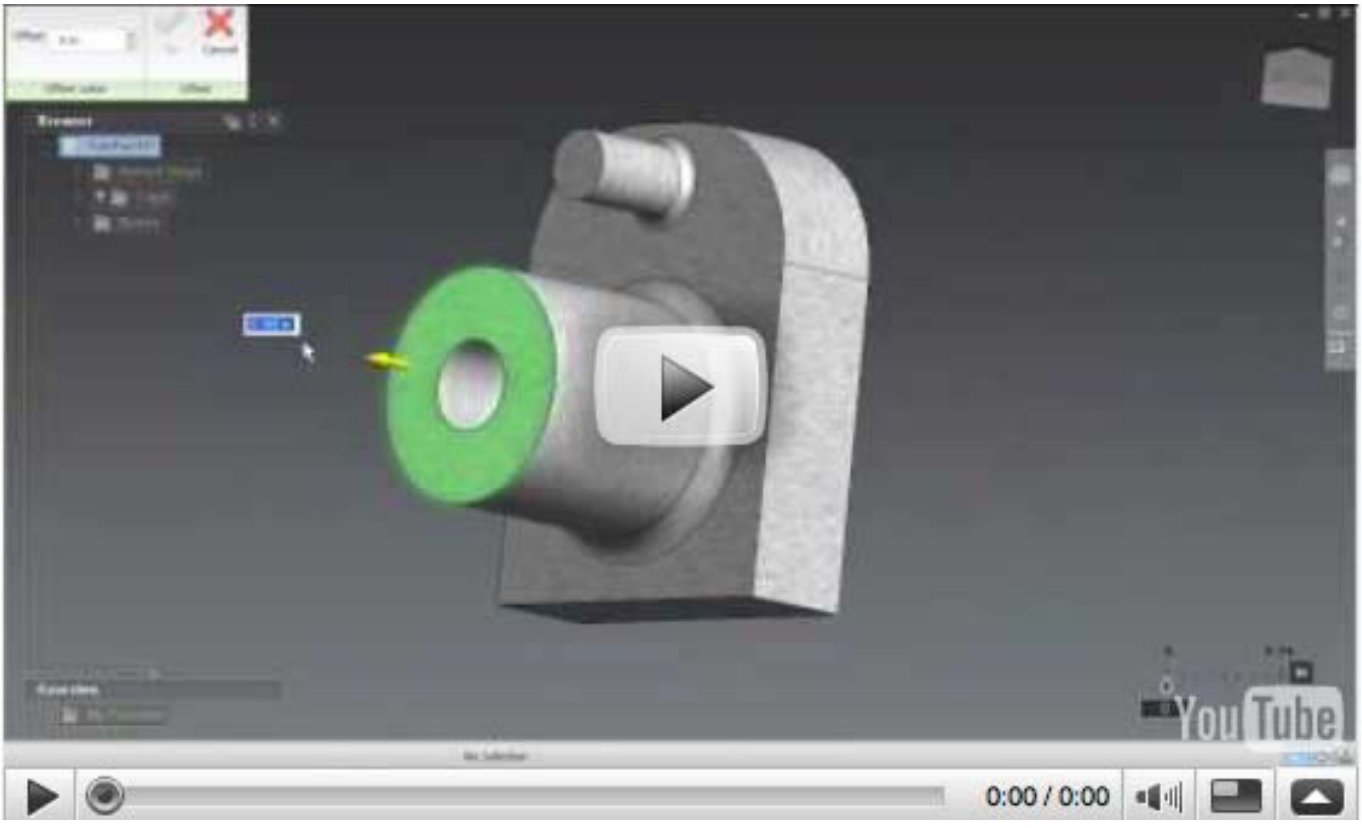
KENNETH WONG
kennethwongsf@earthlink.net

I'm half way into my 30-day trial period of Sustainable Minds, a Web-hosted lifecycle assessment software. With nothing to install, I used the browser-based software from the company to play out a hypothetical manufacturing scenario: I redesigned a toaster in my product line (from Food Happy Corp., my imaginary family-own business) to make it less detrimental to the environment? As it turned out, redesigning the product itseslf wasn't enough. I had to rethink the product's entire lifecycle, including how to deal with its disposal..

Click here to learn more and watch a video of it in action. ■

The Gateway Between Parametric and Direct

Several years ago, the concept of a mechanical CAD program that let you go back and forth between parametric and direct modeling environments seemed like a fantasy. In February, Autodesk announced its development team was on this quest. The Holy Grail of the coveted bidirecional workflow was to be Inventor Fusion. In Release 1, or Technology Preview 1, Fusion offered a way into direct modeling, without a way back to parametric modeling (for more, read "Autodesk Inventor Fusion, Ready for Inspection," June 24, 2009). But the most recent release, Technology Preview 2, fixed that. Read more and see the video. ■



Solutions Are Becoming Easier to Use, not Just Faster

STEVE ROBBINS
steverobbins@deskeng.com

Recently I attended COMSOL's user conference. Though it was one of many user events I've attended over the years, this year's was different from all the others. The company announced the release of COMSOL Multiphysics 4.0, and while simulation has increasingly become faster, this package makes it easier.

During a demonstration in which the software design team was running the program through its paces, engineers in the ballroom kept interrupting the speaker with suggestions on what variables to use, how to define geometry, how to set boundary conditions, and move around the interface. Talk about intuitive!

What really stayed with me from this experience was how fast and easy to use multiphysics has become. This ease of use gives speed and power to the engineer. It helps to move simulations to the very front of engineering design. Simulation software of all stripes is not only faster, but the ease of use in all steps of the modeling process gives the designer

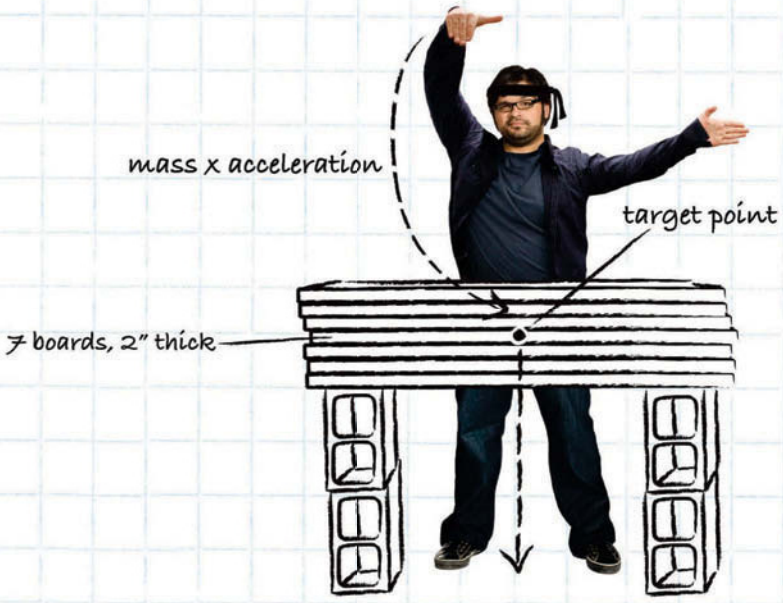
> Inspection and QA is joining simulation at the front of the process.

the ability to change variables in minutes, solve FEA and CFD analysis quickly, and use visualization tools to check the results.

Simulation-based modeling is saving time and materials, and resulting in better products. Changes at the manufacturing stage are reduced. Products get to market quicker. It is interesting to note that the same cycle changes are occurring on the other side of the design process as well. Product inspection is actually beginning to occur well before the manufacturing team takes over.

It used to be an engineer on the factory floor would grab a product sample from the line and set it on the granite table. He then got to work measuring tolerances, comparing metrics on 2D drawings. It took lots of storage and time.

Aerospace manufacturers, however, have already embraced the world of model based definition (MBD). I learned this at a meeting with Dave Olson of



THEY'RE BECOMING BLACK BELTS IN STRUCTURAL ANALYSIS.

NEW EPISODE... CAD NINJA!

3DUDES GONE 3D

SolidWorks® presents a new series about three PRODUCT DESIGNERS forced to work in an overflow trailer. Starring a USER COMMUNITY OVER ONE MILLION STRONG, a friendly NEIGHBORHOOD SOLIDWORKS RESELLER, and more than 150 USER GROUPS. And featuring ACTIVE ONLINE DISCUSSION FORUMS, a set of CUSTOMIZED TRAINING CLASSES, and one CROWD-PLEASING RETURN ON INVESTMENT.

NR
NOT RATED

WATCH SEASON ONE AT **3DUDESGONE3D.COM**

SolidWorks

Verisurf the other day. From design to manufacture, the move to paperless design and the use of 3D models has become a significant driver in simplifying processes and saving time getting to market. It's a change that happened in analysis and simulation a decade ago.

These days, the design team is in control of the simulation, which is now often completed before the actual parametric CAD model is created. Now using MBD, inspection and quality assurance of parts can be accomplished using reverse engineering technology and by comparing metrics to the same 3D CAD model that is used by today's CAM software for manufacturing. There's no 2D drawing involved, all the tolerances exist in the CAD model, and the process takes minutes, not days. The complete enterprise and supply chain benefit. Suppliers can compare scanned data to their customers' models and mistakes are corrected before manufacturing runs. Quality control in real-time.

I have heard from multiple sources that the design-release cycle for American automobile manufacturers is moving from four years to 18 months. It's proof the combination of faster IT technology and easy-to-use simulation and design solutions can be a tremendous driver in today's competitive environment. It drives innovations that will help all of us do our jobs better and improve the world we live in.

Speaking of improving the world, I would like to thank all of the companies that submitted projects to the Change the World Challenge this year. As you read through this issue I think you will be impressed with the designs engineers like yourselves have created. I look forward to seeing your submissions for our second-annual contest next year. ■

***Steve Robbins** is the CEO of Level 5 Communications and executive editor of DE. Send comments about this subject to DE-Editors@deskeng.com.*

EDITORIAL

Steve Robbins — Executive Editor
Jonathan Gourlay — Senior Content Manager
Anthony J. Lockwood — Editor at Large
Margaret S. Gurney — Copy Editor

CONTRIBUTING EDITORS

Mark Clarkson • Al Dean • David S. Cohn • Mike Hudspeth • Tom Kevan • Susan Smith • Peter Varhol
Pamela J. Waterman • Kenneth Wong

PUBLISHER

Brian Vaillancourt (x263)

ADVERTISING SALES

603-563-1631 • Fax 603-563-8192
Brian Vaillancourt — Publisher (x263)
Jeanne DuVal — Account Manager (x274)

ART DEPARTMENT

Darlene Sweeney — Art & Production Director (x257)

A LEVEL 5 COMMUNICATIONS PUBLICATION

Steve Robbins — Chief Executive Officer
Thomas Conlon — President

ADVERTISING, BUSINESS, AND EDITORIAL OFFICES

Desktop Engineering® Magazine
Level 5 Communications, Inc.
1283D Main St., PO Box 1039 • Dublin, NH 03444
603-563-1631 • Fax 603-563-8192
E-mail: DE-Editors@deskeng.com
www.deskeng.com

SUBSCRIBER CUSTOMER SERVICE

Desktop Engineering® Magazine
PO Box 677 • Northbrook, IL 60065
847-559-7581 • Fax 847-564-9453
E-mail: den@omeda.com

Desktop Engineering® (ISSN 1085-0422) is published monthly by Level 5 Communications, Inc., 1283D Main Street, P.O. Box 1039, Dublin, NH 03444, 603-563-1631. Periodicals postage paid at Dublin, NH, and at additional mailing offices. *Desktop Engineering*® is distributed free to qualified U.S. subscribers. Subscription rates for non-qualified: U.S. $108 one year; Canada and Mexico $126 one year; all other countries $195 one year. LIST RENTALS: For information on list rentals, contact Statlistics, Danbury, CT: 203-778-8700.

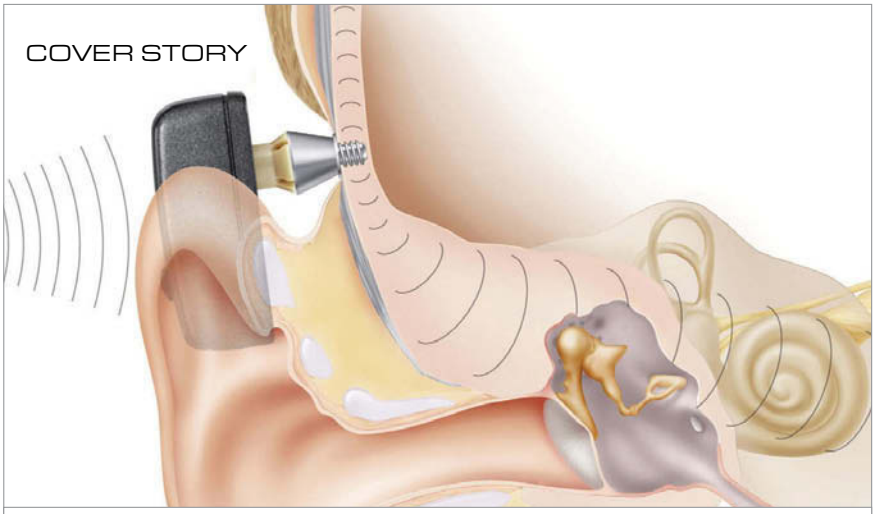
CONTENTS

Desktop Engineering®

DESKENG.COM

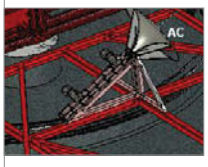
"Computers are useless. They can only give you answers."

> Pablo Picasso

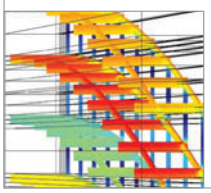


DESIGNS THAT WILL CHANGE THE WORLD

DESIGNS THAT WILL CHANGE THE WORLD



SIMULATIONS THAT WILL CHANGE THE WORLD



CONTENTS

DECEMBER 2009 VOLUME 15 ISSUE 4

SIMULATIONS WILL THAT CHANGE THE WORLD

IT & COMPUTING THAT WILL CHANGES THE WORLD

RAPID TECH THAT WILL CHANGES THE WORLD

DEPARTMENTS

ONLINE @ DESKENG.COM

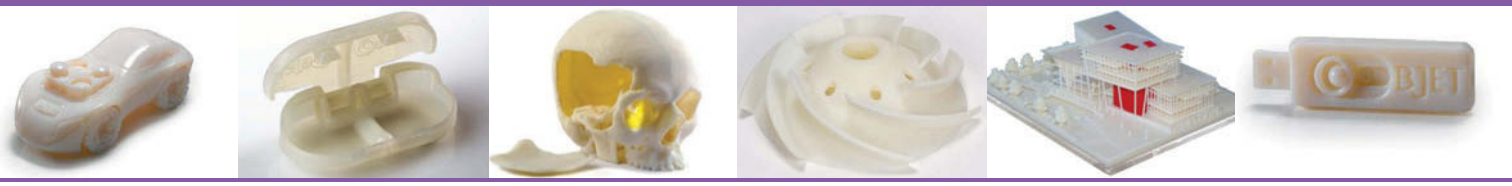
NEWSLETTER REGISTRATION

> *Newslink; Editor's Pick of the Week; Check It Out (Videos, White Papers and Webinars); Virtual Desktop; Elements of Analysis and Simulation; Elements of Engineering IT & Computing; Elements of MCAD; and Elements of Rapid Technologies.*

ON THE COVER >Our first annual awards issue celebrates companies that are changing the world for the better through innovation in each of four categories: design, simulation, rapid technologies, and engineering IT & computing. Awards were designed and created by Trophy Awards Manufacturing, Inc. (trophyawards.com).

Less than you think...

...better than expected!



Compared to the competition the Alaris™30 desktop printer offers you so much more.

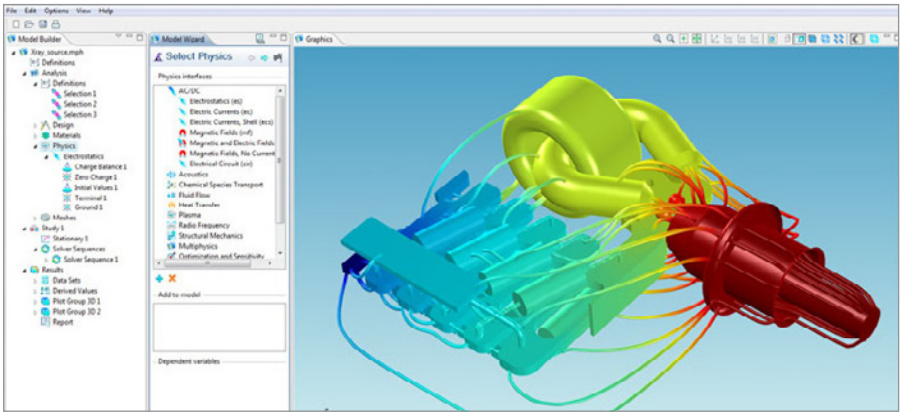
- Higher quality
- Smoother surfaces
- Better accuracy
- Faster builds
- Added value for your business

OBJET
www.objet.com

* Price stated is the lease price per month. Promotion available through US Dealers only. Additional options, shipping and applicable taxes are not included. Offer ends December 31st, 2009.

COMSOL Multiphysics V4.0 Beta Released

COMSOL released the beta edition of COMSOL Multiphysics 4.0 at the Fifth Annual COMSOL Conference in Milan, Italy. Version 4.0 delivers the COMSOL Desktop, a new user interface to facilitate building and running simulations.



"Over the last few years the use of multiphysics simulation has grown rapidly, especially within engineering and R&D departments," says Svante Littmarck, president and CEO of COMSOL. "With the new COMSOL Desktop environment we're making it easier for more engineers to apply multiphysics to more applications."

Users set up the desktop's appearance using its docked window placement capabilities that include the Main menu, Model Builder, and a Help Desk as well as Settings, Messages, and Graphics windows.

The Model Builder enables a dynamic model configuration approach, so building a model is a straight-forward process. Users right-click to perform common tasks such as importing CAD, meshing, specifying material properties, solving, and plotting results. If changes need to be made, the Model Builder provides access to any part of the model settings. Users can record and save setup steps as a model is automatically re-evaluated and refined. Dynamically updated context-dependent help enables easy browsing and extends the search functionality for users.

CAD interoperability remains a top priority to provide a path for CAD users to connect to COMSOL Multiphysics for their simulations. To this end, COMSOL has released the LiveLink for PTC Pro/ENGINEER. By establishing associativity between the two geometry representations, changing a feature in the CAD model automatically updates the COMSOL geometry. This enables multiphysics simulation involving parametric sweeps and design optimization directly from within Pro/ENGINEER. Versions of LiveLink for SolidWorks and Autodesk Inventor are already available as optional add-ons to COMSOL Multiphysics.

COMSOL Multiphysics V4.0 expands the geometry functionality with its CAD Import Module, which is based on the Parasolid Editor geometry kernel from Siemens PLM Software. Users now benefit from CAD tools that support Parasolid-based geometry operations directly in the COMSOL Desktop. COMSOL Multiphysics V4.0 supports parallel processing on standard multicore computers as well as distributed memory systems. Version 4 supports Windows Compute Cluster Server 2003, Windows HPC Server 2008, and Linux.

FOR MORE INFO:

> COMSOL

Autodesk®

AUTODESK INVENTOR TAKES YOU BEYOND 3D TO DIGITAL PROTOTYPING

Autodesk® Inventor® software creates a single digital model that enables you to design, visualize, and simulate your products. Inventor helps you to reduce product costs and get innovative designs to market faster.

Find out more about Autodesk Inventor and how it can take you beyond 3D to Digital Prototyping.

www.autodesk.com/beyond3d

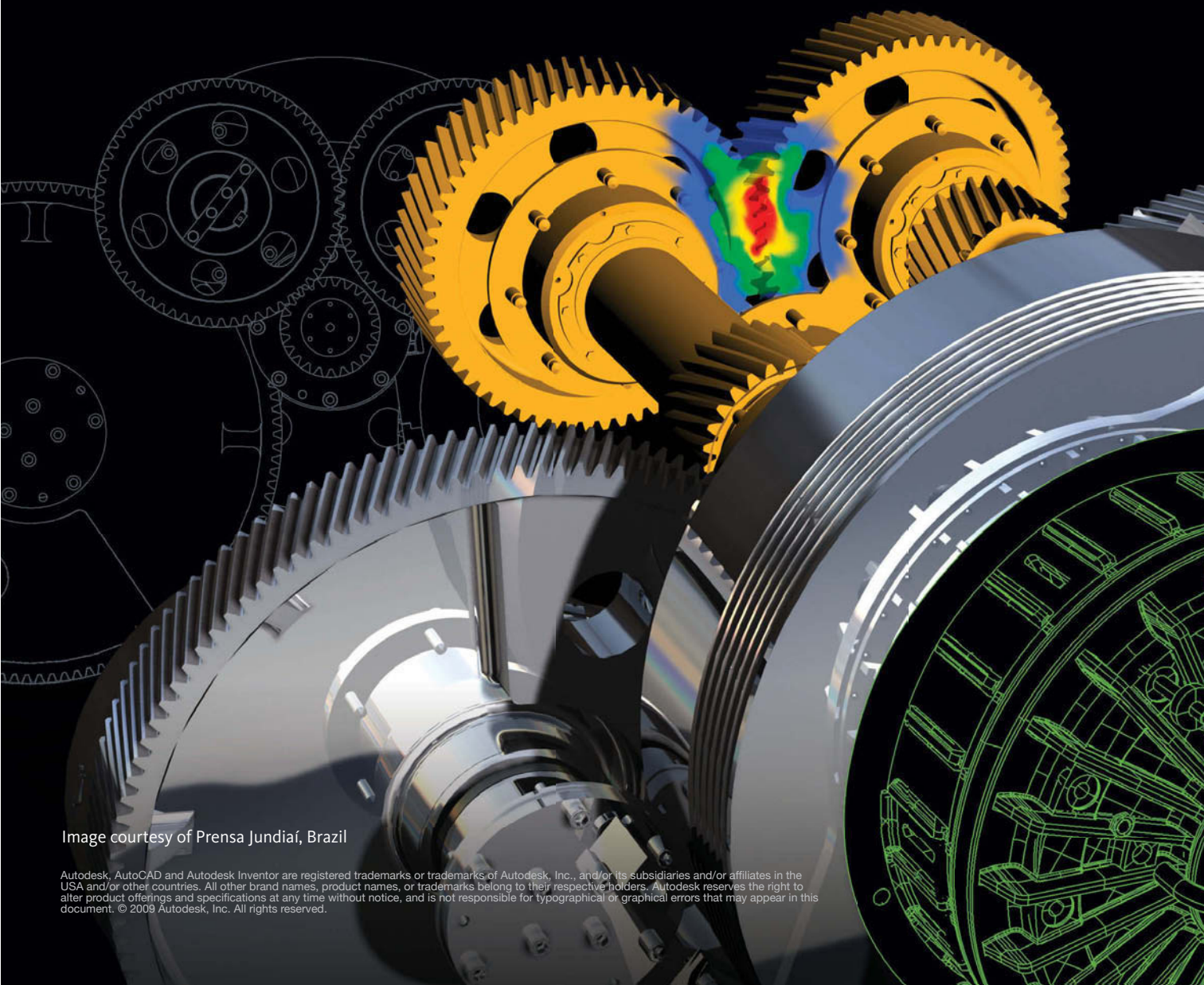


Image courtesy of Prensa Jundiaí, Brazil

Quickparts Offers New FDM Finish Options

Quickparts has announced the availability of new finish options for use in the fused deposition modeling (FDM) rapid prototyping process.

"For our customers who need functional parts, FDM has always been a great process option. Unfortunately, until now, it did not have a great surface finish and that limited how our customers could use it. Now with these new finish options, we have opened the door for our customers to use the FDM process for both functional needs and show quality needs," said Patrick Hunter, vice president of Sales and Marketing for Quickparts. "These new finish options open the door for our customers to use fused deposition modeling for their low volume digital manufacturing needs."

The finishing process is a smoothing process that removes the build layers and provides a near injection molding quality finish, according to the company. The smooth finish is available with either a gloss finish or a matte finish.

FDM materials available for the new finish options include ABS and ABS-M30 production-grade thermoplastics.

FOR MORE INFO:
> Quickparts

NEi Software and Firehole Partner for Composites Analysis in NEI Nastran

NEi Software and Firehole Technologies announced a software integration and distribution partnership that will first focus on leveraging Firehole's multiscale composites analysis technology, Helius:MCT, to deliver advanced composites analysis to NEi Nastran finite element analysis (FEA) users.

Integrating Firehole's Helius:MCT directly into NEi Nastran will enhance the composite-specific toolset with its constituent-based analysis technology. Helius:MCT decomposes the stress and strain fields of a composite material into the stress and strain fields for the fiber and matrix components—allowing insight into the root of composite failure.

Helius:MCT will form the core technology behind NEi's Advanced Composites module, anticipated for release with NEi Nastran V10.0, and will be available with other commercial FEA packages as an add-on.

FOR MORE INFO: > NEi Software

ANSYS Named to Forbes 200 Best Small Companies List

ANSYS, Inc. has been included on the Forbes 200 Best Small Companies in America list, ranking 85th. This is the seventh time that ANSYS has made the list over the past nine years.

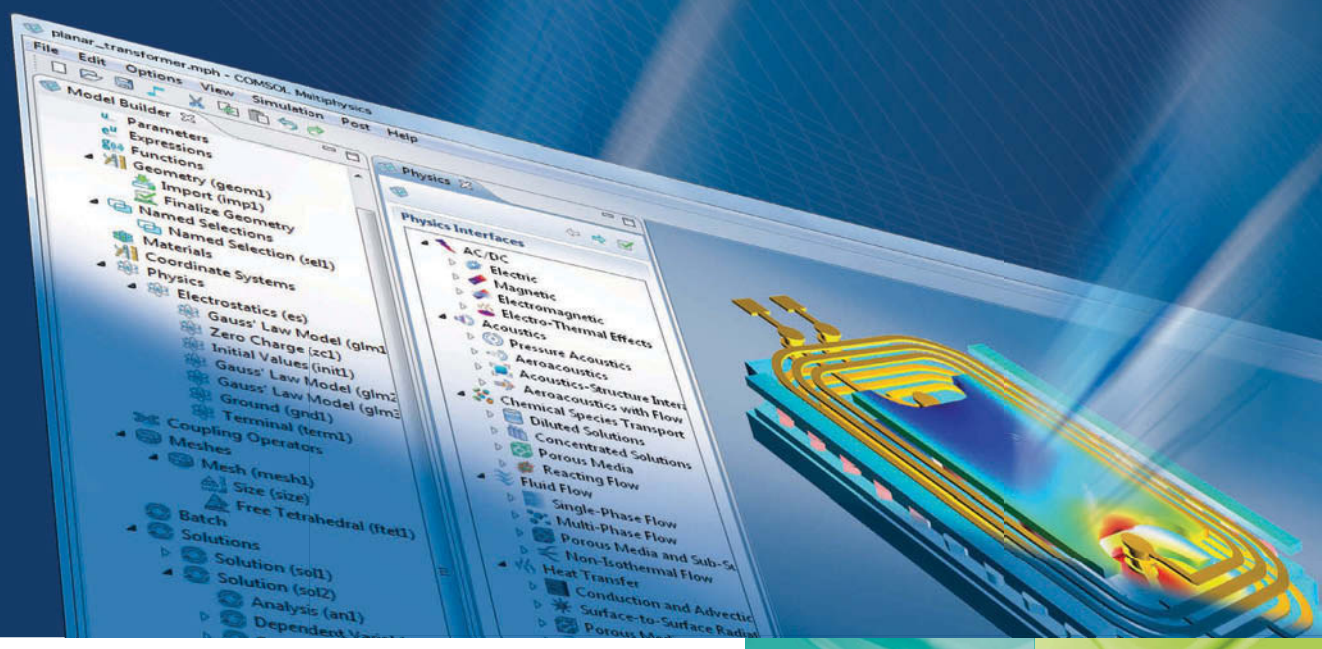
The list includes small-cap businesses that have annual revenues between $5 million and $750 million, have traded publicly for at least a year, and are priced more than $5. Rankings are based on earnings and sales growth, along with return on equity in the past 12 months and over five years.

FOR MORE INFO: > ANSYS, Inc.

COMSOL MULTIPHYSICS®

Capture the Concept

80% of product ideas never make it to market. Let multiphysics simulation bring your designs to life.



With COMSOL Multiphysics® you are empowered to build the simulations that accurately replicate the important characteristics of your designs. The key is the ability to include all physical effects that exist in the real world. This multiphysics approach delivers results—tangible results that save precious development time and spark innovation.

View Multiphysics applications at:
comsol.com/multiphysics

COMSOL

Sustainable Minds Enables Greener Product Design

Sustainable Minds 1.0, a lifecycle assessment (LCA) program designed to help engineers improve the sustainability and lessen environmental impacts of new products, was introduced today by Sustainable Minds. The new SaaS software and information service takes a designer's BOM and offers up comparative analyses of its materials with other similar materials, assigning a sustainability score.

According to Terry Swack, Cofounder and CEO of Sustainable Minds, the on-demand software and its accompanying website integrates three components: The LCA, a learning center so designers can get information on sustainable design practices while they work on their projects, and a community of other designers and researchers to encourage the exchange of ideas.

The core LCA around which Sustainable Minds is designed is, says Swack, is fast and easy to use and provides evaluations in a standardized and repeatable way. She says the hope is designers will use Sustainable Minds 1.0 at the earliest stages of design.

Sustainable Minds uses the Okala Impact Assessment Methodology and runs in Firefox 2 or higher with Flash 8 or higher. Also supported are Explorer 7, Safari 2, Opera 9, Chrome 1 and higher, The BOM import template can interface with any CAD system from which data can be exported. All communication between application servers and the user environment are fully encrypted using 128 bit SSL.

FOR MORE INFO:

> Sustainable Minds

Siemens PLM JT Format Accepted by ISO

Siemens PLM Software announced that the document describing the JT data format, a widely used 3D visualization format, has been accepted by the ISO body responsible for Industrial Data through a global ballot process. According to the company, this event marks the availability of the first ISO publication for 3D visualization in the PLM domain.

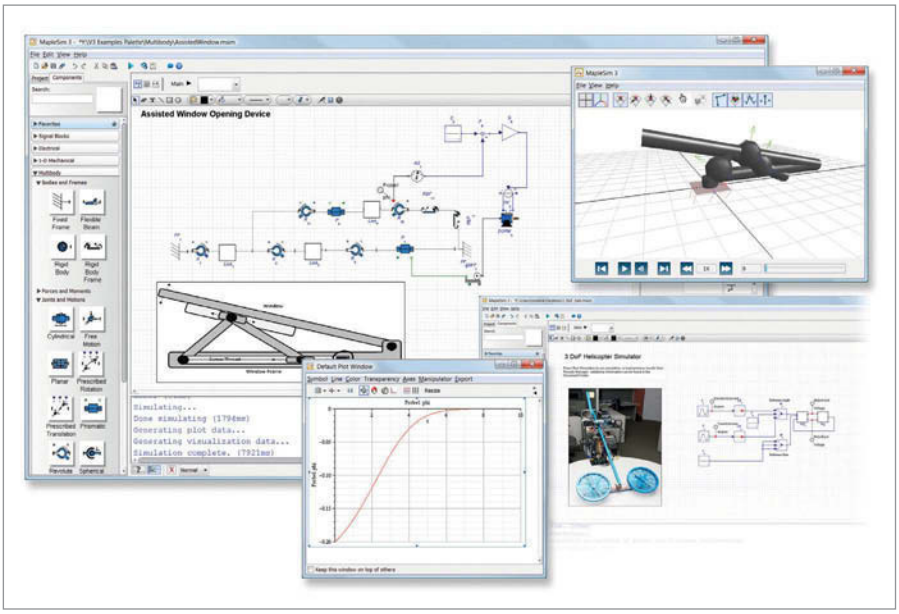
The JT data format has been used by companies for more than a decade to share and visualize 3D product data, and among a variety of CAD and PLM applications.

"Today's announcement is a landmark event for manufacturers all over the world," said Bruce Feldt, vice president of Open Tools, Siemens PLM Software. "Any company working with 3D digital product data in a heterogeneous environment requiring interoperability between internal departments or with external suppliers and partners can benefit from the use of JT."

FOR MORE INFO:

> Siemens PLM Software

Maplesoft Releases MapleSim3 Modeling Software



Maplesoft has announced MapleSim3, MapleSim Control Design Toolbox, and MapleSim LabVIEW Connector.

MapleSim 3 has extended modelling capabilities with new component libraries for hydraulics and electrical machines, and refined solvers that handle greater model complexity. In addition, new user interface features can lead to faster development time and smoother workflow. MapleSim's core symbolic technology produces highly optimized equation-based models.

The MapleSim Control Design Toolbox provides a set of control design tools that extend MapleSim's plant modeling capabilities to support control design. This toolbox takes advantage of the symbolic approach for designing, analyzing, and testing control systems. By developing plants and controllers together in the MapleSim environment, the development process can be accelerated, and tool-switching cost is reduced.

The MapleSim LabVIEW Connector toolbox integrates MapleSim's modeling environment into the LabVIEW real-time platform from National Instruments. Engineers using LabVIEW can quickly develop and optimize complex engineering system models in the intuitive visual modeling environment of MapleSim. This new toolbox joins the MapleSim Simulink Connector (formerly known as the MapleSim Connectivity Toolbox), which provides enhanced connectivity with Simulink and Real-Time Workshop.

FOR MORE INFO:
> Maplesoft

Omega Releases Universal Circular Chart Supercorder

Omega's new series of microprocessor-based portable universal circular chart Superecorders come in four models: temperature and relative humidity, dual thermocouple, dual process, and pH and RTD temperature. A keypad and dual backlit display are located on the front panel. The RS232 PC interface enables downloading recorded data.

Features include double-sided chart paper and a magnetic hub.

Prices start at $795

FOR MORE INFO: > Omega Engineering, Inc.

EDITOR'S PICK OF THE WEEK

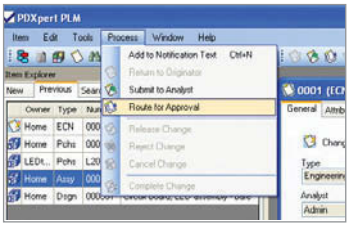
FROM THE DESK OF **ANTHONY J. LOCKWOOD**, EDITOR AT LARGE, *DESKTOP ENGINEERING*

WOULD YOU TRUST THIS GUY? Well that question has already been answered by thousands of readers who have indicated they already do, implicitly. So here are Lockwood's most recent musings about the products that have really grabbed his attention, and deserve yours.

PLM System for Growing Innovative Companies

>PDXpert improves data accessibility and security minus high-end PLM.

Small manufacturers often have growing pains as reward for success. When starting out, many small manufacturers felt that they had to rely on such tools as e-mail, telephone, and spreadsheets to manage their data because that was what they could afford. As their data expanded with new products, clients, suppliers, and expanded lists of approved parts, their spreadsheets grew out of hand, printouts of important e-mails got buried in folders, and people simply forgot whether they were ever told about an engineering change.



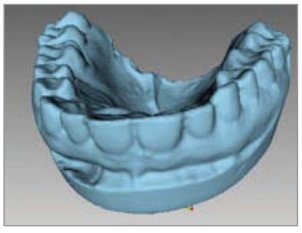
PDXpert has the most-wanted PLM functionality needed by small enterprises: bills of materials, vaulting, document control, configuration management, workflow management, engineering change request and change orders, supplier source management, automatic rules-based document and part numbering, standardized approvals, and so on.

READ MY COMPLETE REVIEW:

>PDXpert

Scanners Capture 3D Images Like a Camera

> Hand-held Artec3D Scanners from Exact Metrology require no mounts or markers.



Exact Metrology recently added Artec3D hand-held scanners to its line-up of metrology products. I think I'm in lust. The Artec3D line has many attractions. Start with the way you use it: You simply grab it and move around your object of interest, scanning it at various angles. No mounts or markers. The Artec3D's software combines the scanned images into one image automatically.

I should mention here that the Artec3D comes in a couple of versions, each with variations for different work. The thing about the Artec3D Scanner is that it's almost a 3D camera. Now, I've got to admit that when I first got wind of the Artec3D, I was a bit stumped that it uses no markers and by what the company says it can do for about $15,000. It appears to me that they make this process about as simple to execute as possible.

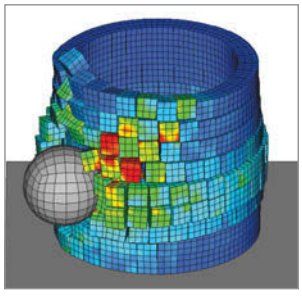
The Artec3D uses a texture camera and a 3D sensor to capture the surface shape and texture simultaneously.

READ MY COMPLETE REVIEW:

>Artec3D

Simulate Large Models Under Nonlinear Response

> New application solves for extreme nonlinear material response, large deformations.



A memorable moment of my youth – or "yute" for fans of *My Cousin Vinny* – was when Armstrong took his one small step onto the moon for us. My grandfather, born years before the Wright brothers' flight, was watching it on TV. Snapping out of his dementia, Poppy, a natural engineer with a 6th grade diploma, looked at me with a huge smile and joie de vivre in his eyes I had never seen nor would again and exclaimed, "that guy is on the Moon!" Small steps can be the key to making great things happen.

And many small steps is how NEi Software's new NEi Explicit can help you make great things happen. The nub of it is that NEi Explicit broadens the NEi Nastran FEA environment with capabilities to simulate extremely large models undergoing highly nonlinear response and large deformations, such as high-speed impacts where the event is measured in milliseconds or less—say, metal stamping or a bird hitting a jet turbine blade. The key to it is that NEi Explicit handles such phenomena with a small-footprint, dynamics algorithm that uses many, small computationally efficient time steps—thousands really—to predict the motion of a body from all the data known at the beginning of each time step.

READ MY COMPLETE REVIEW:

>NEi Software

Extend Rhino with Free-Form CAD Surfacing

> T-Splines 2.1 introduces techniques for free-form surfacing said to trim hours from design processes.

T-Splines has just come out with version 2.1 of its T-Splines for Rhino plug-in toolset that enables manufacturers to create free-form organic shapes. Anybody tasked with surfacing—well, OK, wise guys, not macadamizers nor intonacatori—should download the evaluation unit and give T-Splines a look because it might save you hours of time and let you be more creative. The company also makes a version for Maya.

The point with T-Splines is that it's not NURBS, but it's both similar to and import-export compatible with NURBS. The benefit is that T-Splines lets you work with shapes as if they were fungible, similar to what animators do, only optimized for CAD, manufacturing, and industrial design. It lets you model complex shapes with a single smooth watertight surface that, depending upon your process, is ready for analysis and manufacturing.

This means that you push and pull shapes. You add geometry and drag faces, edges, or vertices. You can also easily make holes or extrusions with a single surface rather than jiggering and trimming multiple surfaces.

READ MY COMPLETE REVIEW:

>T-Splines

Autodesk Inventor Dispels Sounds of Silence

> Cochlear uses advanced technology to design and develop a breakthrough hearing aid that opens the world of sound to the hearing impaired.

BY TOM KEVAN

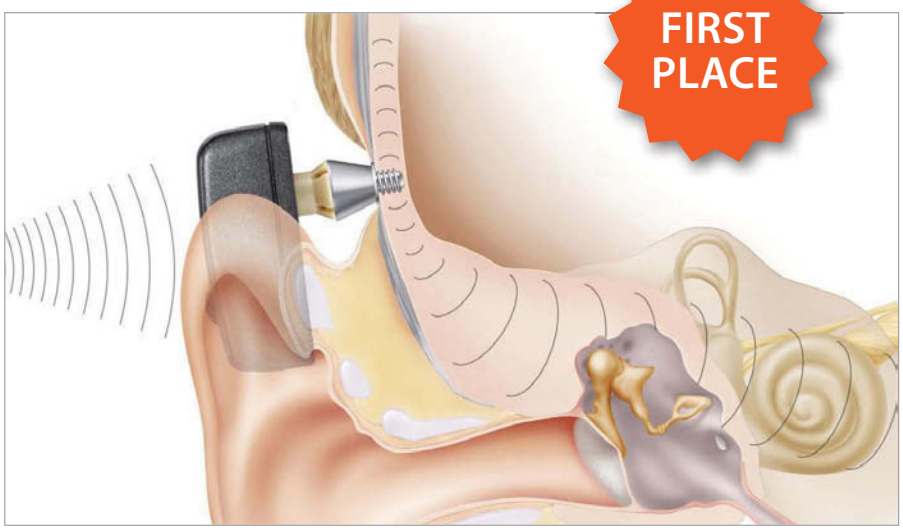


Figure 1: The BAHA's sound processor picks up sound vibrations and passes then via an abutment to the implant. The abutment tranfers the sound vibrations from the processor to the small titanium implant in the bone, behind the ear. The implant transfers the sound vibrations through bone to the functioning cochlea. *Image courtesy of Cochlear Ltd.*

The winners and runners-up of DE's Change the World Challenge all offer solutions to problems plaguing our world. All promise to have a big impact on many peoples' lives. All are impressive in their scope regardless of simplicity or complexity.

In the Design category, the first-place winner differs from the others in this section in that it works within an already accepted framework of solutions to the particular problem it seeks to solve. This in no way detracts from the genius of the design or the accomplishments of the designers. The real import of this difference is that it doesn't require an established and accepted infrastructure be scrapped and replaced by an out-of-the-box approach. It does not require those with significant financial interests in maintaining the status quo to step aside. It therefore has a much better chance of widespread use, and its impact is less of a question, and more of a statement.

The winner of the challenge in this category is the BAHA (Bone Anchored Hearing Implant) hearing system by Cochlear Bone Anchored Solutions, a division of Cochlear Ltd. It offers those with certain types of impairments a chance to hear and function normally in everyday life. For children, this can open the way for them to develop speech and attend school much like any other student.

For many people with hearing loss, it removes a major obstacle to doing ordinary things that most of us take for granted, such as crossing a street, going to a restaurant, participating in a professional meeting, or simply driving a car. It promises to restore hearing to those that other solutions cannot help.

The scale of the problem the BAHA solves is enormous. Thirty-five million people in North America alone suffer from hearing loss. According to the Hearing Review, one in six people between the ages of 41 and 56 have a hearing problem. One in 14 between the ages of 29 and 40 suffer hearing loss. And 1.4 million children cannot hear properly. Other documentation estimates that globally, approximately 278 million people have moderate to profound hearing loss in both ears.

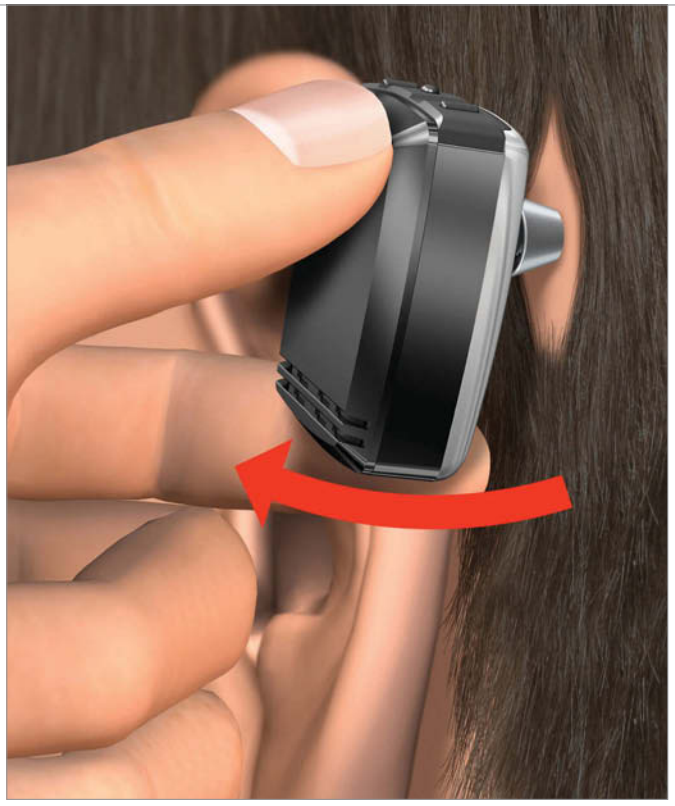


Figure 2: The sound processor snaps onto the abutment, which is attached to the titanium implant in the bone.
Image courtesy of Cochlear Ltd.

The Design Team

The complexity of the BAHA was matched by the composition of its design team. The group's disciplines included mechanical, electrical, and software engineering. Because of the nature of the device, the designers needed special knowledge in the fields of signal processing and acoustics.

The team used a systems approach, which is based on the belief that the parts of a system can be best understood within the context of their relationships to each other and to the system as a whole, not in isolation. "All the BAHA's components work very closely together," says Mats Dotevall, Director of Design and Development for Cochlear Bone Anchored Solutions. "One of the big technical challenges was feedback. In a hearing aid like this, you have a microphone and vibrator. Sometimes when the skull bone vibrates, the signal comes back to the microphone, causing feedback. Every system component was involved in the feedback issue. So we worked very closely together as a team."

Design Tools

The primary tool used to design the BAHA was Autodesk Inventor, a 3D parametric solid modeling software package. Cochlear adopted Inventor because it needed to be able to precisely design, engineer, and manufacture parts on scales of 1/100 or 1/1000 of a millimeter, and the software's modeling functionality made it possible to work with very small components and tolerances.

Inventor's 3D digital prototyping also allowed designers to visualize and simulate the product

before it was built, reducing the number of physical prototypes the team had to construct, and improving the overall ef ciency of the development process.

In addition to Inventor, the design team used electronics CAD systems to optimize the size and manufacturability of the circuit board, as well as acoustic, electromagnetic, and signal-processing simulation tools for modeling things such as feedback characteristics, vibrator ef ciency, and sound-processing performance. The software engineers used various tools for software development, testing, and validation.

The Problem

In most cases, a person with hearing loss is fitted with a traditional hearing aid, which carries sound by air conduction, through the ear canal, eardrum, and ossicles. Traditional hearing aids use a microphone to pick up sound from the environment and convert it to an electrical signal, which is sent to an amplifier. The amplifier increases the strength of the signal (the volume of the sound) and sends it to a receiver/speaker, which changes the electrical signal back to sound and sends it into the ear.

There are situations, however, where this type of device does not work. In these cases, the person's ear canal or the malleus, incus, and staples bones, which transmit and amplify vibrations to the eardrum and inner ear, are damaged or do not function.

The Solution

Clochear's solution for this type of hearing loss is the BAHA system, which uses the bone the makes up the skull as an alternative sound path to enable a person to hear. Much like air, bone can conduct sound vibrations. In cases when the middle ear is blocked, damaged, or occluded, the BAHA bypasses the outer and middle ear and naturally stimulates the cochlea through bone conduction (see Figure 1). Once the cochlea receives the sound vibrations, the organ hears in the same manner as that affected through air conduction. The sound is converted to neural signals, which are transferred to the brain, allowing the person to perceive sound.

The BAHA concept of using bone to conduct sound arose when it was observed that by placing a tuning fork against an artificial tooth, anchored by a titanium implant, patients with impaired hearing could hear the sound well. Other hearing devices use bone conduction to enable hearing by pressing a vibrator against the skull, but many believe the perception of sound this way is not as good. This is because sound vibration and intensity are dampened by skin, muscle, and fat, especially the high frequencies critical for understanding speech.

The BAHA system uses a titanium implant, which is placed in the skull bone behind the ear. An abutment connects a sound processor to the implant in the bone (see Figure 2). The processor collects the sound vibrations, amplifies them, and passes them to the implant, which conducts the vibration through the skull bone to the f uid in the inner ear.

Although the Baha system has been in use since 1977, Cochlear treated it as a work in progress. As new technologies have been introduced and re-

fined, the company's design team took advantage of them to expand their vision of just what the hearing system could do and how it could best help those with hearing impairments. In 2003, the designers cashed in on the digital revolution by replacing the original sound processor, which relied on analog amplifiers, with a digital component. With this modification, the new Cochlear Baha BP100 model offers advanced digital signal processing and is PC-programmable, which enables a clinician to individualize the unit's sound to best meet specific patients' needs.

Today, almost 60,000 people can hear because of the BAHA hearing system. The number of those who could benefit from the device, however, is in the millions. The true impact of the BAHA is not expressed in numbers, though. "In the end, it is a quality of life product that makes big changes in peoples' lives," says Dotevall. The ability to hear transforms the social, educational, and professional facets of the lives of those who use this device. ■

Contributing Editor ***Tom Kevan*** *is based in New Hampshire and is DE's mechatronics, PLM, and systems expert. Send your comments about this article to DE-Editors@deskeng.com.*

FOR MORE INFO:

> Autodesk Inc.

> Cochlear Americas

Rethinking the Internal Combustion Engine with Autodesk Inventor 2010

> In an age in which so many are advocating the demise of the internal combustion engine, Grail Engine Technologies' design team wants to make it better.

BY TOM KEVAN

The Grail Engine's design team used Autodesk Inventor 2010 extensively, which allowed the engineers to develop a completed, constrained, and animated 3D assembly model in 19 weeks.

The irony of so many of humankind's solutions to problems is that they introduce new, unforeseen problems of their own. Consider those who propose reducing or eliminating the negative effects of the internal combustion engine by expanding the use of batteries. Sounds good at first blush, but what happens to the batteries at the end of their operational life? Do they end up in a landfill? Would we be replacing one problem with another?

Grail Engine Technologies decided it would be better to improve the internal combustion engine than to replace it, and began its design process in April 2009. The result is a state-of-the-art two-stroke engine that achieves morethan 100 mpg—improving fuel efficiency 50 percent over current vehicles—while extensively reducing exhaust emissions. The power plant operates on multiple types of fuels, including biodiesel, ethanol, gasoline, alcohol-based fuels, propane, methane, hydrogen, and natural gas, and reduces the production cost of automobiles.

The Design Team

Matthew Riley, Grail's CEO and chief research scientist, developed the original engine concept. He was joined by Nicholas Bennington, Grail's president and chief engineer, and the two

breakthrough quantum leap

Revolutionary. Period.

Synchronous Technology can help you do your job up to 100x faster.

"We chose Solid Edge with Synchronous Technology unanimously. When the 2D designers started using Solid Edge it just came naturally and transparent, much different than if we had chosen SolidWorks®."

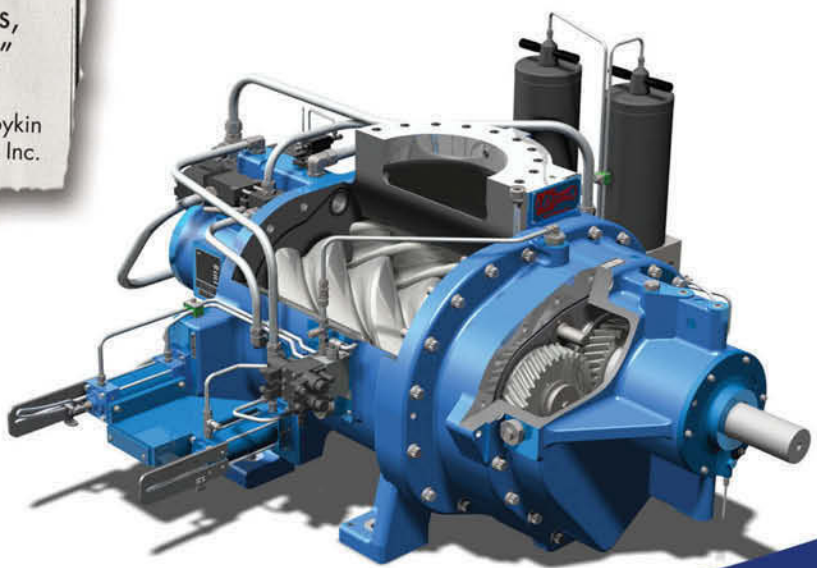
Tony Tan
Systems Analyst, American Renolit Corp.

"We changed from Inventor® to Solid Edge with Synchronous Technology and now can make changes in a half hour as opposed to half a day, product development time dropped from six months to three months, giving us time to attract more customers."

Darryl Boykin
Engineering Manager, Eckel Manufacturing Inc.

If you are using SolidWorks,® Pro-Engineer,® or Inventor,® find out how Solid Edge ST can make your design experience faster and easier.

Go to our website to register for a seminar in your area.



Join the Solid Edge Revolution.

Go to www.designfusion.com or call 1-866-921-1830 to register.

designfusion

Chicago I Philadelphia I Toronto I Montréal I Winnipeg

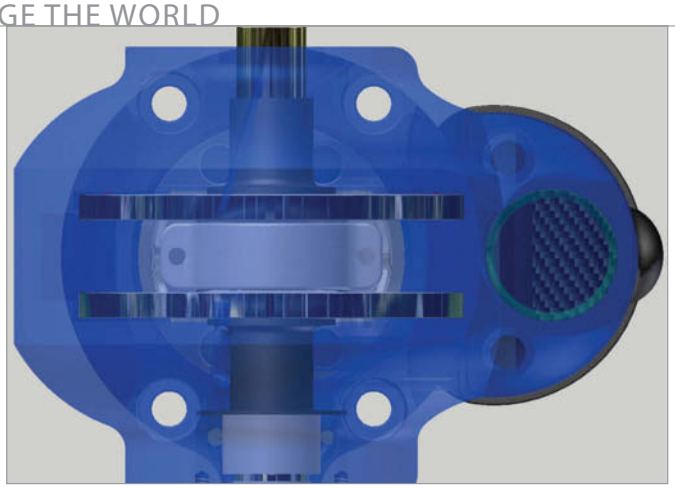
did the initial steps of the design. Between the two, they had expertise in the fields of internal combustion engine design, ignition systems, and emissions technology. Then, with the aid of the CAD Department of the Salina Area Technical College, Riley and Bennington refined the design.

The Grail team's primary design tool was Autodesk Inventor 2010. By using its tools, the engineers were able to move from the initial design to a completed constrained and animated 3D assembly model in 19 weeks. The Autodesk Inventor suite of tools enabled them to optimize the engine's weight and f ow characteristics, as well as perform stress analysis and reduce bill of material costs. The design team also used stereolithography rapid manufacturing tools to identify design issues, make form-fit and function changes, and visualize f ow conditions of the engine.

The Engine

The Grail two-stroke engine consists of a single exhaust valve, three spark plugs, and a direct fuel injector—all located at the top of the cylinder; a single intake valve located within the piston; a pre-compression chamber that houses a one-way reed valve; two vent-to-piston ports; two piston-intake ports attached to the piston that travel within the vent-to-piston ports; and a crank case with minimized volume. As a result, most of the compression takes place within the pre-compression chamber, vent-to-piston ports, and piston intake ports.

Fresh air enters the external pre-compression chamber, vent-to-piston ports, and piston-intake ports via the one-way reed valve, as the piston



The state-of-the-art two-stroke Grail Engine achieves over 100 mpg, improving fuel efficiency 50 percent over current vehicles, and significantly reduces exhaust emissions. The power plant operates on multiple types of fuels, including biodiesel, ethanol, gasoline, alcohol-based fuels, propane, methane, hydrogen, and natural gas.

travels upward in the cylinder. Compression occurs within the combustion cylinder as the piston travels upward. At the piston's top dead center position, direct ignition and multiple ignition occurs, forcing the piston downward in the combustion cylinder, compressing air in the engine crankcase, external pre-compression chamber, vent-to-piston ports, and piston-intake ports.

Just prior to the piston reaching the bottom dead center (BDC) position, the exhaust valve opens via a standard cam-rod mechanism. Exhaust gases are expelled with pre-compressed fresh air via the piston valve and piston-intake ports. As the piston moves past the BDC position, the exhaust valve closes, and the cycle repeats.

Adjusting the volume within the external pre-compression chamber via a servomotor or an equivalent allows you to control engine outputs and efficiency at multiple engine speeds.

The Grail two-stroke engine can also simultaneously use the Miller cycle and homogeneous charged

compression ignition. Because of this, the engine achieves excellent, clean, and efficient performance, which Grail claims is unmatched by any other engine on the market, at half the manufacturing cost.

FOR MORE INFO:

> Autodesk Inc.

> Grail Engine Technologies

> Salina Area Technical College

The Impact

The Grail engine's ability to deliver significantly better mileage, reduce fuel consumption and emissions, and cut automobile production costs holds much promise.

One of the most intriguing aspects of the design is its ability to use multiple types of fuel, but the absence of the infrastructure necessary to support extensive use of some of these types of fuel, such as hydrogen, is the main obstacle to the engine's having a major impact on the world. If the supporting infrastructure becomes a reality, the improvements offered by the Grail Engine could have far-reaching effects. But for the near term, developing the infrastructure seems to be a big if. ■

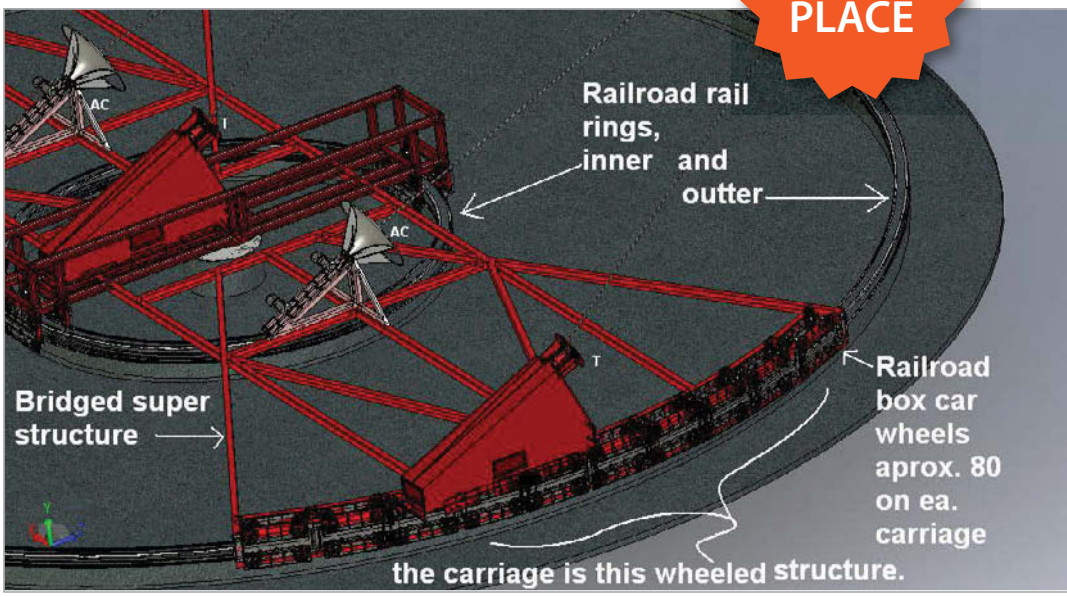
*Contributing Editor **Tom Kevan** is based in New Hampshire and is DE's mechatronics, PLM, and systems expert. Send your comments about this article to DE-Editors@deskeng.com.*

Blimp-based Power Plant Modeled in SolidWorks

> Aerostat Wind Turbines has a keen interest in problem solving and an entrepreneurial spirit to raise wind power to a new level.

THIRD PLACE

BY TOM KEVAN



The base station of the Airborne Wind Turbines anchors the platform to the ground and accommodates changes in orientation with a structure made up of inner and outer rail rings and approximately 80 railroad car wheels. As the airborne blimp self orients to the direction of the wind, the base station tethers move along the rings.

Barstow, CA–based Aerostat Wind Turbines has taken existing technology and materials, as well as time-proven concepts, and created the Airborne Wind Turbine (AWT). The design promises to enhance energy production, reduce manufacturing costs, drastically reduce the time required to achieve a return on investment, and deliver inexpensive electricity, particularly to remote locations.

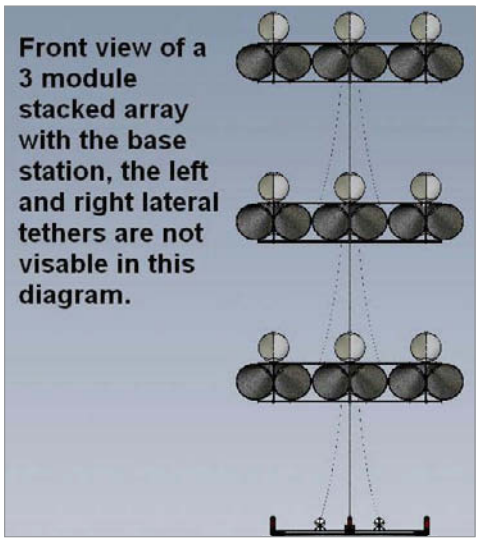
The Design Team

Aerostat's design team is a unique collection of people, and the team's unusual composition shakes up conventional thinking about innovation and design.

The concept for the AWT was the product of an "idea man," but not a trained engineer. Lynn Potter, the inventor of the AWT, is by profession a prosthetist. His efforts were supported by Brad Merrell, an engineer with the civil engineering firm of Merrell Johnson; Jim Merrell, who helped with project management; and Christopher Gorham, who produced the system's CAD drawings.

Aerostat's team used SolidWorks to design

the ATW's base station and shrouded turbine modules. The software proved particularly helpful in identifying spatial conf icts that occurred among system components. For example, the design tool enabled them to see where guy-wires would intersect and then develop solutions that optimized operations. They also used Autodesk's AutoCAD Civil and ENERCALC's Structural Engineering Library to calculate the configuration and strength requirements of the footings and foundation of the structure used to anchor the airborne system so that it could withstand the forces experienced when the system was aloft.



Aerostat's Airborne Wind Turbine modules contain six turbines. These are attached to the ground base station by tethers. The modules can be stacked in multiple layers, 1,000 ft. apart, beginning at 1,000 ft. and going up to 30,000 ft.

The Problem

Not all locations are practical or cost effective for ground-based wind-generated energy production. Some locations do not have dependable, consistent wind to drive turbines. Many areas that do enjoy steady wind suffer from periods of high turbulence. To generate energy in these areas, the turbines must be rugged enough to withstand the destructive bursts of wind over their operating life. To meet these structural demands, and still be large enough to produce necessary quantities of electricity, ground-based wind turbine manufacturing costs can be high.

The Solution

The best conditions for wind-turbine operation are 1,000 to 30,000 ft. above ground level. At these altitudes, turbulence is greatly diminished, and wind speed is continuous and stronger than it is on the ground.

For its design, Aerostat uses a tethered blimp, with six-turbine modules attached to the system's base station. A shroud, or funnel, positioned in front of each turbine, concentrates the wind to higher pressure and velocity. Because the shrouds are suspended in the atmosphere, they can be 10 times larger than similar structures on ground-based systems. At the back of the turbine, a diffuser creates a vacuum that draws out and disperses the wind.

Because each turbine is shrouded, Aerostat was able to reduce the weight, size, and cost of the turbine blades. The blades can be similar in size to those found in a car turbo. The blades can also run at higher speeds, which allowed Aerostat to eliminate the gearbox and achieve greater efficiency.

The turbine modules attached to Aerostat's AWTs can be stacked in layers 1,000 ft. apart up to 30,000 ft. The blimp self orients into the wind. Electricity is transmitted to the ground via a coaxial tether.

The Impact

The AWT solves one of the major problems blocking the broader use of wind-generated power systems. Regardless of wind conditions on the ground, an airborne platform places the turbines where the wind is continuous and strongest, making the overall system reliable and efficient. This approach makes geographic areas currently unsuitable for wind-generated power systems viable sites for this application.

It does not, however, solve objections relating to appearance and the 500 ft. height limit prescribed by the Federal Aviation Administration. As a result, governmental approval for testing and operation becomes problematic. ■

FOR MORE INFO:

> Aerostat Wind Turbines
> Autodesk Inc.
> ENERCALC Inc.
> SolidWorks.com

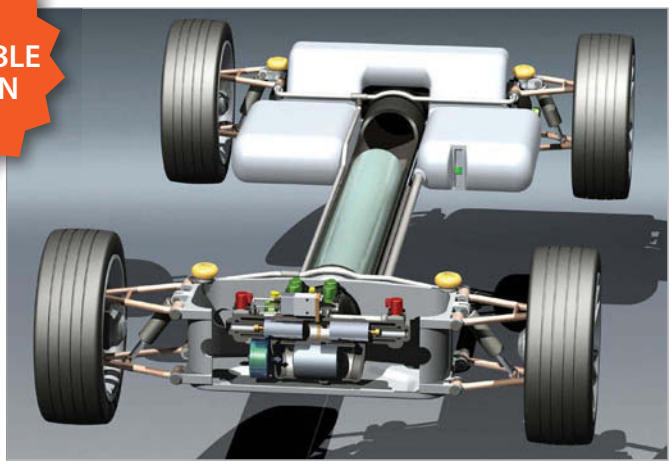
Tom Kevan *is a New Hampshire-based freelance writer specializing in technology. Send your comments about this article to DE-Editors@deskeng.com.*

SolidWorks Enables Innovative Auto Design

> This car is a composite of new technologies that promise significant potential benefits, but requires consumers and the automotive industry to accept change.

BY TOM KEVAN

HONORABLE MENTION



This SolidWorks model shows the engine located in the front box of the accumulator assembly, including opposing pistons, accumulator plungers, and red and green magnets to control the fluid flow.

Innovation is often thought to spring from a flash of insight that occurs out of the blue. In fact, most creative designs are the product of years of work that build on linearly evolving concepts, pulling together the knowledge of the best minds in an industry. That is the case with the Ingocar, a hydraulic hybrid, whose design began in the mid 1980s.

Ingo Valentin's five-passenger Ingocar reduces the weight of the typical automobile platform by 50 percent. Its high-efficiency powertrain increases mileage to an incredible 170 mpg. The new combustion system is projected to reduce emissions significantly. And the unique design simplifies product planning, manufacturing, and maintenance, bringing costs down.

The Design Team

Valentin, the sole member of the Ingocar's design team, began cultivating the expertise for this project when he developed a hydraulic motor for Hydromatik GmbH (now Bosch-Rexroth) in the mid 1970s. While he actually started the design in the 1980s, in early 2008 Valentin gleaned support from Prof. Rolf Reitz of the University of Wisconsin at Madison; Scott Goldsborough of Marquette University; Peter Achten of INNAS Corp. in The Netherlands; and Prof. Monika Ivantysynova of Purdue University.

Valentin adopted SolidWorks for its capabilities in the areas of dimensions, interference, and forces. It also enabled him to obtain data for the simulation and manufacturing of vehicle components. The software allowed Valentin to better address quality control and time-cost savings issues.

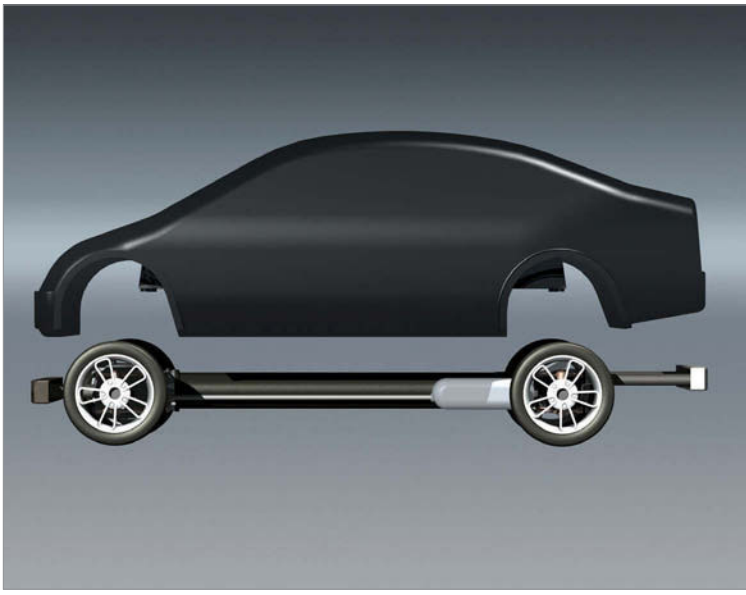
Problems and Solutions

The Ingocar is based on a new hydrostatic powertrain, with energy storage. Its main components are a new free-piston combustion engine, an accumulator to store energy, and new axial-piston wheel motors, one in each wheel. The accumulator is the load-carrying backbone of the car, and the engine, wheels, and active bumper system are attached to it. The car body is simplified and significantly lighter because the road forces are carried by the accumulator.

When braking, the motors are reversed and recoup the braking energy by pumping the fluid back into the accumulator.

The hydraulic engine pumps fluid into the accumulator and turns of automatically when the accumulator is fully charged. The pressurized fluid drives the wheel motors. When braking, the motors are reversed and recoup the braking energy by pumping the fluid back into the accumulator. The round-trip-efficiency during braking is about 75 percent. Therefore, energy is consumed only to overcome the rolling resistance of the tires and the air drag of the car.

The free-piston engine (38 hp) operates at nearly constant speed and power when charging the accumulator. A new circumferential fuel injection system, with ultra-high injection pressure (50,000 psi) and a pressure wave charger mechanism, improves the thermal efficiency and power density of the engine. This reduces both fuel consumption and emissions significantly. How big an impact it will have depends on how willing car makers are to accept this level of change. And change never comes easy. ■



This rendering, developed in SolidWorks, shows the Ingocar body (top) and the car platform (bottom). The accumulator (the horizontal component between the wheels) is the load-bearing backbone of the vehicle. The active hydraulic front and rear bumpers automatically extend 20 in. before a crash occurs.

Tom Kevan *is a New Hampshire-based freelance writer specializing in technology. Send your comments about this article to DE-Editors@deskeng.com.*

FOR MORE INFO:

- > Bosch-Rexroth
- > Marquettee University
- > Purdue University
- > SolidWorks Corp.
- > University of Wisconsin

FASTApps

> FOR COMPLETE APPLICATION STORIES CLICK HERE

Okino Enables Virtual Oil Refinery On Time and On Budget

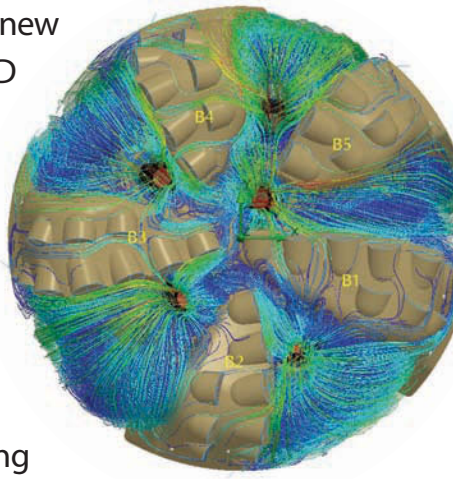
> A provider of high-quality animations and multimedia for Fortune 500 companies was contracted by an engineering firm to create a virtual oil refinery. The project also called for the creation of an animated fly-through and a tour of each of the refinery units. The AutoCAD models provided by the engineering firm—which were to provide the data upon which the animations were to be based—were huge, preventing the multimedia provider from opening and converting the 3D CAD files to animations in 3ds Max. The multimedia company needed expert help and software that could tackle the translation process.

With the help of Okino Computer Graphics' PolyTrans|CAD software, the multimedia provider was able to work through a streamlined translation and optimization process, using the CAD models to create a dazzling interactive oil refinery presentation. Through the use of Okino's software, the company completed the project on budget and on time.

> More info

Mentor Graphics CAD-Embedded CFD Streamlines Design Optimization

> Encore Bits LLC, a relatively small oilfield drill bit manufacturer, uses advanced CFD technology to optimize products without incurring the expense of dedicated experts.



The company uses a new generation of CFD software embedded in CAD software that enables its design engineers to optimize the fluid flow characteristics of each of its bit prototypes during the design phase. This approach reduces the time and cost required to perform CFD simulation.

The new CFD tools use native 3D CAD data, perform automatic gridding of the flow space, and manage flow parameters as object-based features, eliminating the need for engineers to understand the computational part of CFD. To operate the new software, the engineer must simply understand the CAD system and the physics of the product. All this allows the engineer to focus on optimizing the performance of the product, as opposed to operating the software.

> More info

FASTApps

> FOR COMPLETE APPLICATION STORIES CLICK HERE

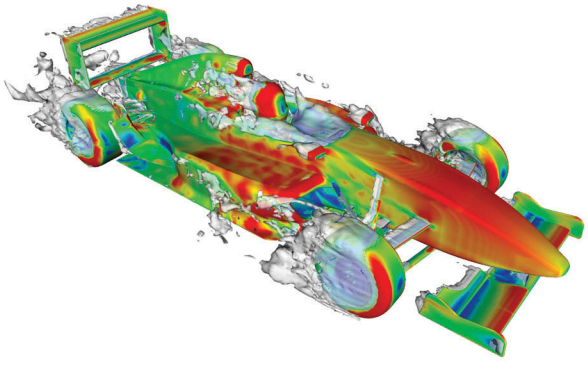
Exa Corp. Uses Spatial Kernel In Geometry Prep Tool

> Exa Corp. is an engineering software company that offers a suite of CAE and CFD simulation tools, as well as consulting services. Always looking to enhance and accelerate the product development process, Exa conceived the idea of PowerDELTA, an innovative geometry prep tool.

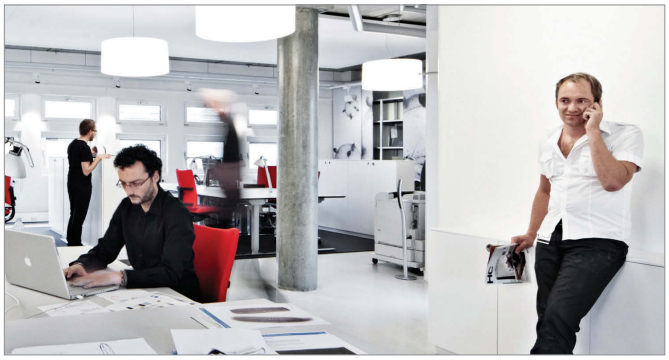
Many competing case preparation tools require the customer to put facets on their CAD models or to use external meshing tools to begin preprocessing. To avoid the shortcomings encountered in using the competing tools and to provide complete end-to-end functionality, the new PowerDELTA software had to include a 3D geometry kernel and CAD format translators. Although Exa's product developers had extensive experience in the mathematics behind NURBS and solid modeling, they did not have the expertise to cost-effectively develop this additional technology.

The solution to the problem was for Exa to integrate an ACIS kernel and 3D translators from Spatial into PowerDELTA.

> **More info**



Cisco Uses Z Corp Printing to Uphold the Scandinavian Design Tradition



> This is the story of how designers combine time-honored aesthetic principles with 3D printing technology to produce some of the world's most elegant consumer electronic equipment.

The challenge confronting the Cisco Consumer Business Group was that traditional handcrafted prototypes are time consuming and expensive to create. Unfortunately, using some automated rapid prototyping technologies can be just as costly and must be outsourced, adding time and inconvenience to the process. The goal was to find a way to uphold aesthetic standards and meet deadlines in the highly competitive consumer electronics business, where time to market is critical.

Z Corporation's 3D printing technology helps Cisco quickly create physical models, maintain exacting design standards, and get products to market on schedule. ZPrinting produces prototypes in hours instead of weeks, at one-fifth the cost.

> **More info**

Tormach makes it easy to get started

Tormach's Personal Manufacturing Workshops

- *Introduction to CAD/CAM*
- *CNC Fundamentals*

Introducing Tormach's Personal Manufacturing Workshops, developed specifically to help designers, engineers, inventors, and small business owners apply CNC in product development and small-scale manufacturing. The workshops, taught by Tormach's own engineers and machinists, provide hands-on training in the operation of the PCNC 1100 and personal manufacturing techniques in fixturing, work holding, machining process planning and design, NC programming, and more. Students who attend the workshop will become confident in using the PCNC 1100 to transform their designs and prototypes from art to part as they model and build their own desktop Stirling engine.

Visit www.tormach.com for upcoming class dates and details.

PCNC 1100
SERIES II
$10,540
(plus shipping) includes mill, stand, coolant system, computer, and accessory arms

Tormach's PCNC 1100 is a real machine tool for making real parts, at a price and size that makes sense for today's designers. With the precision you need and the power to cut todays toughest materials, the PCNC 1100 is the answer for flexible and affordable prototyping and custom manufacturing.

PCNC 1100 features:

- 5000 RPM spindle
- Ground ballscrews
- 1500 lbs. of precision iron and steel
- Easily cuts plastic, aluminum, steel, even titanium
- Options include digitizing probe, 4th axis, quick change tooling, and more

For more information visit www.tormach.com or call 608.849.8381

TORMACH™

www.tormach.com

Green Ocean Energy Rides the Wave with ANSYS

> Scotland's Green Ocean Energy is poised to perfect its wave-powered energy-generation system using a suite of analysis and modeling software.

BY DAVID ESSEX

The Wave Treader, developed by Green Ocean Energy and optimized using ANSYS software, mounts on the base of an offshore structure such as a wind turbine or tidal turbine. It produces 500kW of electricity from onboard generators powered by wave action that raises and lowers floating arms, which sit atop buoyant sponsons.

It is ironic that the north of Scotland, a center of the oil & gas industry thanks to its proximity to North Sea oil fields, is an important front in the worldwide movement to replace fossil fuels with renewable energy. But the region's already vibrant engineering community is not only riding the new wave of innovation to new opportunities, it is making them possible.

Green Ocean Energy in Aberdeen might be the best example. The company is a spinoff of the oil & gas engineering firm Nordeng and its use of simulation technologies to develop machines that will ride the ocean to generate electricity earned it the first-place winner in the simulation category of Desktop Engineering's Change the World Challenge.

"It's a truly innovative sector," says Carl Rudd, the Aberdeen-based regional sales manager for ANSYS, the Pittsburgh, PA-based company whose simulation and design tools formed the development platform. "These guys are pushing the boundaries of engineering."

The challenge was to design a device that was affordable enough to manufacture but could last 25 years, says George Smith, the company's managing director. Smith, a Nordeng director since its inception in 1987, says he was pondering the possibilities of wave energy when he came up

This is an ANSYS simulation of the stress distribution in the Ocean Treader arm.

with the concept of Ocean Treader, a freestanding device with parts that move up and down with the waves, using the motion to turn a generator.

The company instead turned its focus to Wave Treader, a smaller, more economical version that can be attached to rigid structures. Though it has roughly half the output of Ocean Treader and is less tolerant of rough waves, it should be easier to commercialize, according to Smith. Besides, Ocean Treader presents an additional design challenge: how to attach its power cable to the f oating parts.

Wave Treader consists of sponsons at its front and aft ends, and a spar buoy (a type of tall, thin, upright buoy) in the center. As a wave passes, the forward sponson lifts and falls, then the buoy lifts and falls slightly less, and finally the aft sponson lifts and falls. The relative motion between the three is harvested by cylinders that pressurize hydraulic f uid, which, after smoothing by accumulators, spins hydraulic motors and electric generators. "We use a hydraulic system to effectively smooth out the energy," Smith says.

Suite Science

Smith focused on structural analysis, using ANSYS DesignSpace and GRAITEC's SuperStress. Others on the four-person team tackled analysis in ANSYS AQWA and The MathWorks' MATLAB. "ANSYS allows us to make sure that everything is designed to the correct level," Smith says. "If something is over-designed, it means it will be too heavy and too expensive. If it is under-designed, it will fail."

Rudd says ANSYS Workbench is the foundation on which the other tools rest. Third-party integration played a role. The ANSYS tools can read data from MATLAB, and a single-port ANSYS integration in the 3D modeling and digital prototyping tool, Autodesk Inventor, was expanded to multiple ports. ANSYS trained and worked closely with the team, helping to design and test several scale models. "We took on an initial study for them to look at their design in AQWA," Rudd says, by importing a file of an Ocean Treader design.

Analyst engineer Tamas Bodai says he had to learn hydrodynamics before using AQWA, which he essentially controls from MATLAB. The team used AQWA to build a model based on the components' geometry, density, and inertia. They entered wave data to calculate hydrodynamic parameters, such as hydrostatic stiffness and buoyancy, as well as f uid dynamics forces such as diffraction, a measure of a f oating body's effect on waves. The parameters were then fed into code that calculates the kinematic response and power output.

Bodai says he spent much of his time determining how wave movements across the sponsons and buoy could be most beneficially captured, which often became a function of sponson length.

"If you want to do it precisely, it takes a very long time," Bodai says. "One thing is to make sure that the experiment is what you intend to do so you don't misinterpret the data. You have to make sure it's detailed enough and complex enough to capture a certain phenomenon."

The team has used a 1:12.5 scale model to verify AQWA's calculations, and the software has performed well, according to Smith. "We've got quite a high level of confidence," he says.

Some load and resistance analysis was handled by engineering consultancy Prospect, who also reviewed designs. It focused especially on the impact of Wave Treader on the operational life and reliability of the support structures of offshore wind turbines, a contribution Smith calls pivotal. Prospect used data from a wind farm to determine if a Wave Treader could be added without modifying a turbine's foundation or upgrading the power cable. The issue is crucial to Wave Treader's viability. Prospect's analysis showed it would add 500 kilowatts of output at no additional cost—one-third the output of a turbine, but at constant rates.

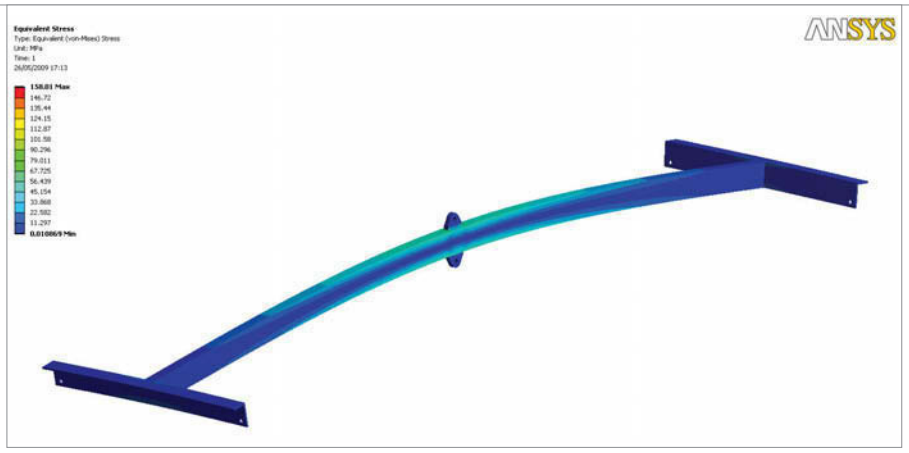
"Wave-loading analysis to the level of complexity needed for the design of wave energy abstraction devices is notoriously dif cult," says principal engineer Kevan Stokes. Prospect's work led to a better understanding of phase shift between the parts of Wave Treaders and to improvements in access for people who will build and maintain them at sea—coincidentally an advance in wind turbine technology, he says. Smith explains that the current approach requires technicians literally to jump from boats onto towers. Now, they will be able to jump more safely onto a Wave Treader sponson that, like the boat, is moving at the same rate as the waves.

Another technical partner, Cadherent, imported Green Ocean Energy's design models into Autodesk 3ds Max to develop photorealistic animations of device movement, which was helpful in designing access platforms and explaining the setup to potential investors. "The most challenging aspect for us was to accurately simulate the buoyancy of the Wave Treader and the Ocean Treader," says Cadherent Managing Director David Thomson. "I understand that interfacing with a conical wind turbine column was a challenge for Green Ocean, which would have proved much harder if it were not for modern CAD programs."

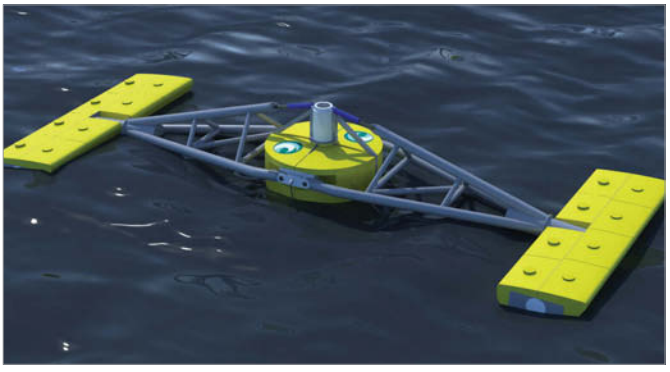
Just Over the Horizon

Smith says the company is raising money and finalizing designs to build a full-size prototype next year. "We're looking at the electrical and hydraulic system design," he says. "We're looking at the sustainability of the machine," including simulating the load during storms. "It's really about surviving huge waves." Smith says waves average 2-3 meters at the prototype's likely location, but can reach 7-8 meters. "We have to be sure that for any given site, we design for the worst possible scenario," he says. Then the company will turn its attention to manufacturing issues, with hopes of commercialization in 2011. "We're like the Model T: we're very early on in this industry."

The design is attracting notice from numerous quarters, including the Scottish government, which gave it a SMART award for technically challenging innovation. "Wave Treader is immensely popular, it seems," Smith says. "We have had tremendous



This is an ANSYS deformation simulation of a spreader beam structure that lifts the Ocean Treader machine safely into the water.



The Ocean Treader, developed by Green Ocean Energy and optimized using ANSYS software, is moored to an anchor. It produces 500 KW of electricity from on-board generators powered by wave action that raises and lowers floating arms, which sit atop buoyant sponsons.

interest from operators of offshore wind farms." The growth potential seems huge, and the oil & gas industry, with its rigs and platforms, is another potential target. "Any offshore structure which is rigid, we could probably attach a Wave Treader to," Smith says, adding that the devices could also have their own platforms. The British government estimates that marine energy could fill five percent of Europe's energy needs, he says.

Desktop engineering will play a big role in this energy future, Stokes says. "Wind turbine power output, for example, used to be considered unreliable because it was unpredictable, but there are now ever-improving software programs that are very good at predicting this," he says. "We will have reliable, cost-effective, renewable energy production systems that are several orders of magnitude kinder to the environment than those that we use at present, and this will only be possible as a consequence of the computer-based design and engineering software that we have."

Rudd says the stakes are high for ANSYS users like Green Ocean Energy. "They have to get these products right, because financial constraints don't allow them to build a full-scale prototype," Rudd says. "When the full-scale model—which really is the product, basically—goes into the sea, it's got to work the first time. Think of the cost if that thing falls to the bottom." ■

*Freelance writer **David Essex** has covered IT for 23 years. He was a BYTE editor and has written for Computerworld, PC World, among other publications. Send e-mail about this article to DE-Editors@deskeng.com.*

FOR MORE INFO:

> ANSYS
> Autodesk Inc.
> GRAITEC
> Green Ocean Energy
> The MathWorks

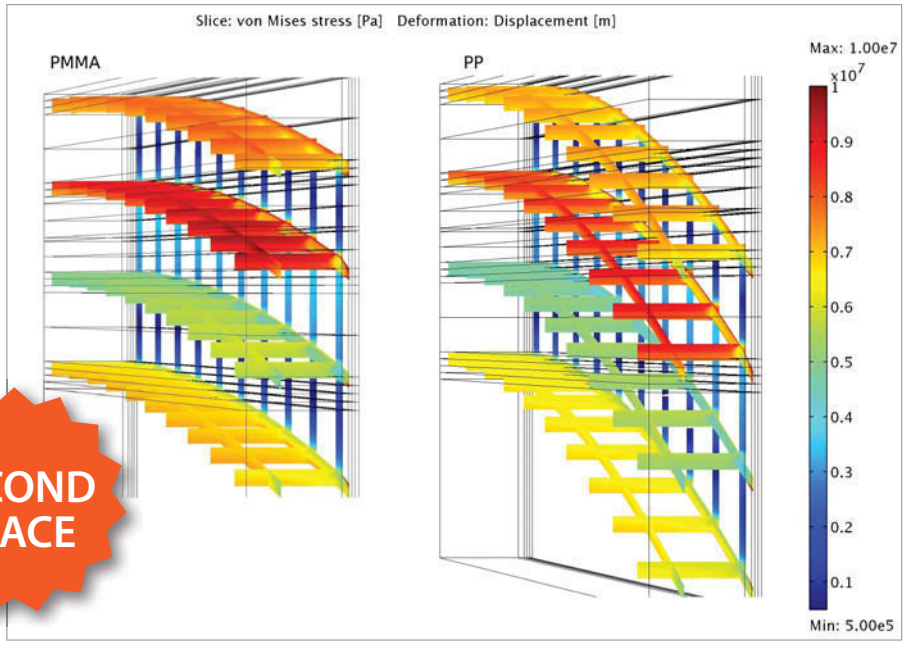
New Solar Collector Materials Modeled with COMSOL Multiphysics

> Researchers at the Fraunhofer Institute for Solar Energy Systems use COMSOL to model characteristics of new polymeric materials.

BY KARL-ANDERS WEISS

Since an estimated half of fossil fuels burned are used for heating purposes, there is a huge potential in replacing them with renewable energy sources such as solar collectors. Today's standard collectors use copper or aluminum as the energy-absorbing material, but consider that if we were to meet just 1 percent of the world's heating energy with conventional solar collectors, it would require 22 million tons of copper. The worldwide output of copper in 2006 was 17.6 million tons. Add to that recent price increases in metals and there's a clear impetus to examine much less-expensive polymers as an alternative.

SECOND PLACE



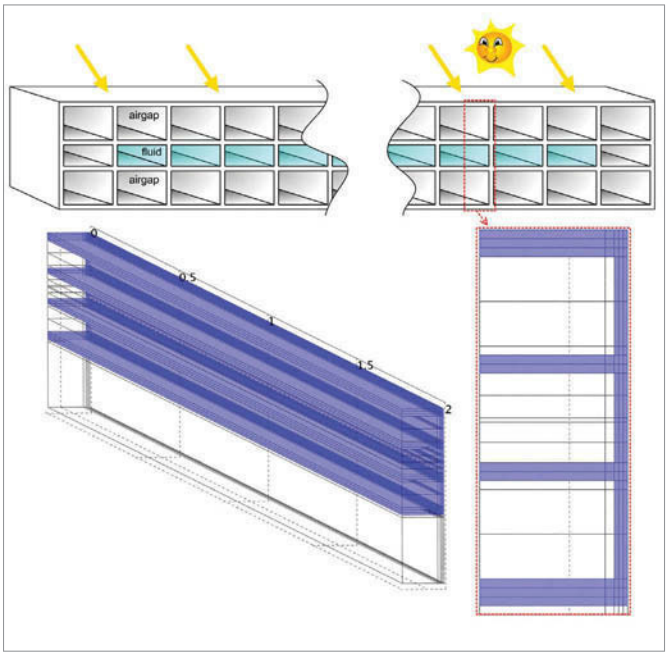
The Von-Mises stresses within a polymer-based solar collector at a normal inlet temperature of 350K can vary widely depending on the material. Here a comparison of the stresses and deformation between polymethyl methacrylate (left) and polypropylene (right) is shown.

However, polymers don't have the same ability to withstand high temperatures as metals, so we need completely new designs for polymer-based solar collectors. In studying new concepts we are starting from scratch and use modeling to understand virtually every aspect of an energy

system's operation including heat transfer due to fluid flow, heat-induced structural deformation and stress, plus the mass transport of water through barriers. COMSOL Multiphysics provides an excellent platform that allows us to examine all of these within one easy-to-use environment and to optimize system operation before we start building prototypes.

Design Optimization for Collectors

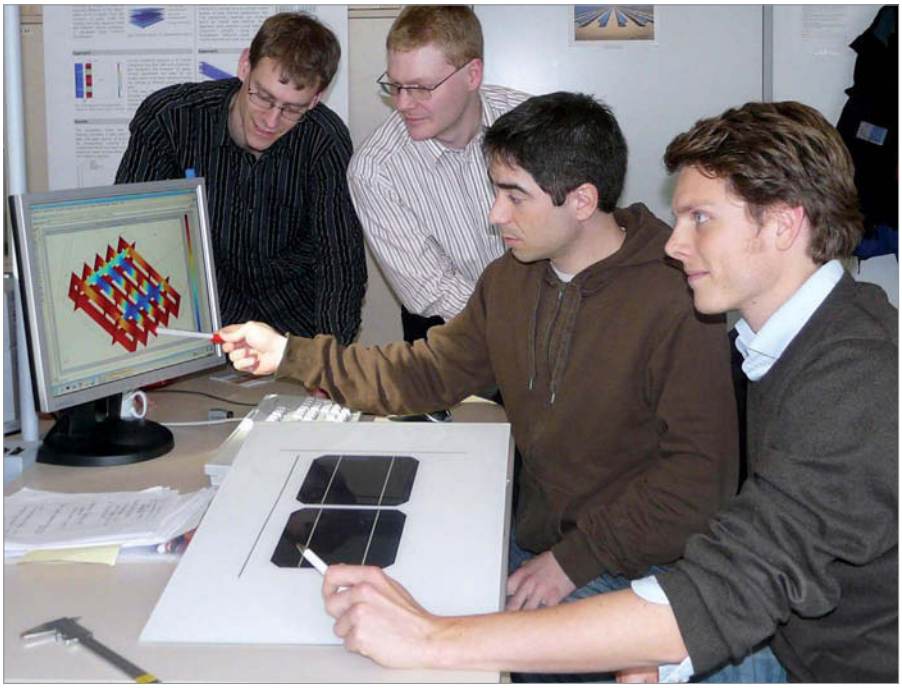
The use of polymeric materials in solar energy applications offers many advantages. First, of course, is its price compared to today's collector materials. Next, polymers offer great freedom in terms of design—we can develop new collector



This diagram shows a possible geometry for a solar absorber made of polymer materials.

layouts that would be impossible using conventional materials. For example, with an extrusion process it might be possible to mass-produce complex geometries in lengths of kilometers and bring economies of scale to bear. Further, polymers allow the manufacture of collectors that are lighter in weight than those of metal.

Polymeric materials have a low intrinsic thermal conductivity. This, however, can be compensated for by optimizing collector geometries with the goal of a layout that assures homogenous flow and maximized contact area between the absorber and the heat-transfer fluid. With solar collectors, heat transfer is certainly dependent on a material's thickness and heat conductivity. But an even more predominant effect can be the heat-transfer coefficient between the fluid and the wall, which is determined by the fluid dynamics in the vicinity of the surface, and they depend on the surface's shape. Because polymeric materials can have almost any form, we want to optimize a polymeric absorber's shape so that heat transfer by convection overcomes the lack of heat conductivity.



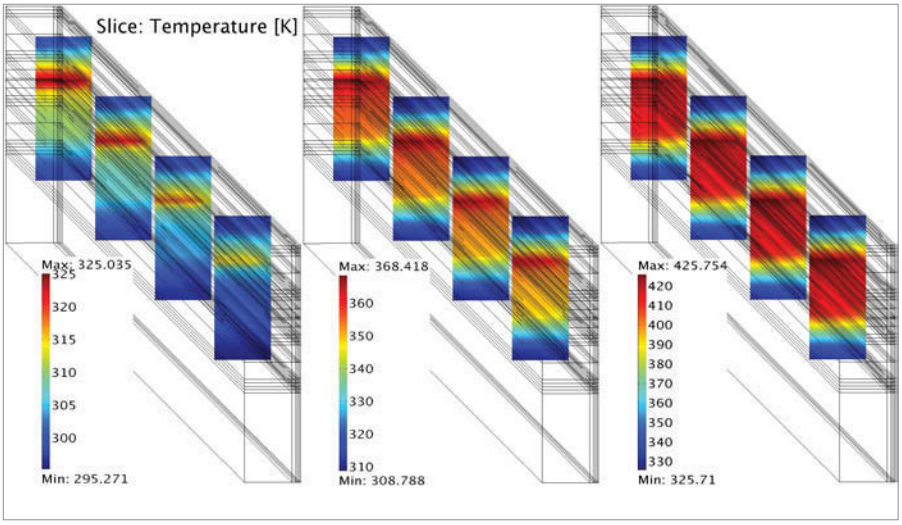
Fraunhofer researchers studying the COMSOL simulation results are (left to right) Georg Mülhöfer, Karl-Anders Weiss, Jochen Wirth, and Philip Hülsmann. Steffen Jack is missing from photo.

Advantages of design optimizations are best described by the results of adding an additional plate as absorber into the design, which could increase the internal conductance from 95 W/m2K to 540 W/m2K.

One possible layout (above) for a thermal absorber was based on multi-wall sheets where the heat-transfer fluid passes through channels surrounded by air to provide heat insulation from the environment.

Collector Stress Levels Analyzed

However, collectors deform when heated, so stress distribution and deformation represent potential risks for their stability and durability, especially at mechanical connection points. We want to estimate a product's useful lifetime due to mechanical stresses that arise during both normal operation and during stagnation, the worst-case situation when the energy storage system is no longer able to accept heat from the collector.



This is a temperature distribution of a 2 m long fluid channel with absorbing surface on top of the absorber for inlet temperatures of 300 and 350 K (left and middle) and stagnation (right).

We set up a COMSOL model that accounts not only for the temperature distribution that varies with the position of the absorber layer but also for other factors that affect the temperature level including the amount of irradiance, inlet temperature, and the collector's thermal losses. This temperature data enables the determination of the collector's deformation and mechanical failures reducing the service lifetime.

Humidity Transport in PV Modules

While the previous model dealt with solar collectors, polymers also play a role in improving the cost efficiency of photovoltaic (PV) solar modules. These consist of a front cover of glass, encapsulated solar cells, and a back-sheet, which is usually made of polymeric materials. These polymeric back-sheets and encapsulants provide a barrier to keep humidity, atmospheric gases, and pollutants away from the silicon solar cells and protect them mechanically.

The ingress of humidity is a serious reason for their degradation, which can hardly be measured without physically destroying the module. Therefore, we work on developing measurement technologies and model the humidity transport.

Thanks to our modeling, we can compare different polymeric collector geometries and materials for various energy carriers to reach an optimized collector design in terms of efficiency and price. We have also confirmed that our design is as efficient as conventional collectors and that the mechanical stability is sufficient if the collector is constructed properly. Our next steps are to model longer time periods to guarantee sufficient durability for our future partners in industry. ■

Karl-Anders Weiss *earned his degree in physics and economics at the University of Ulm, Germany. He has been with the Fraunhofer Institute for Solar Energy Systems focusing on durability analysis and environmental engineering since 2005. Send comments about this article to DE-Editors@deskeng.com.*

FOR MORE INFO:

> COMSOL

> Fraunhofer Institute for Solar Energy Systems

Abaqus FEA Leads to Lifesaving Heart Pump

> Sunshine Heart and SIMULIA win third place by optimizing a unique pump design to make sure the human heart continues to beat.

BY LYNN MANNING

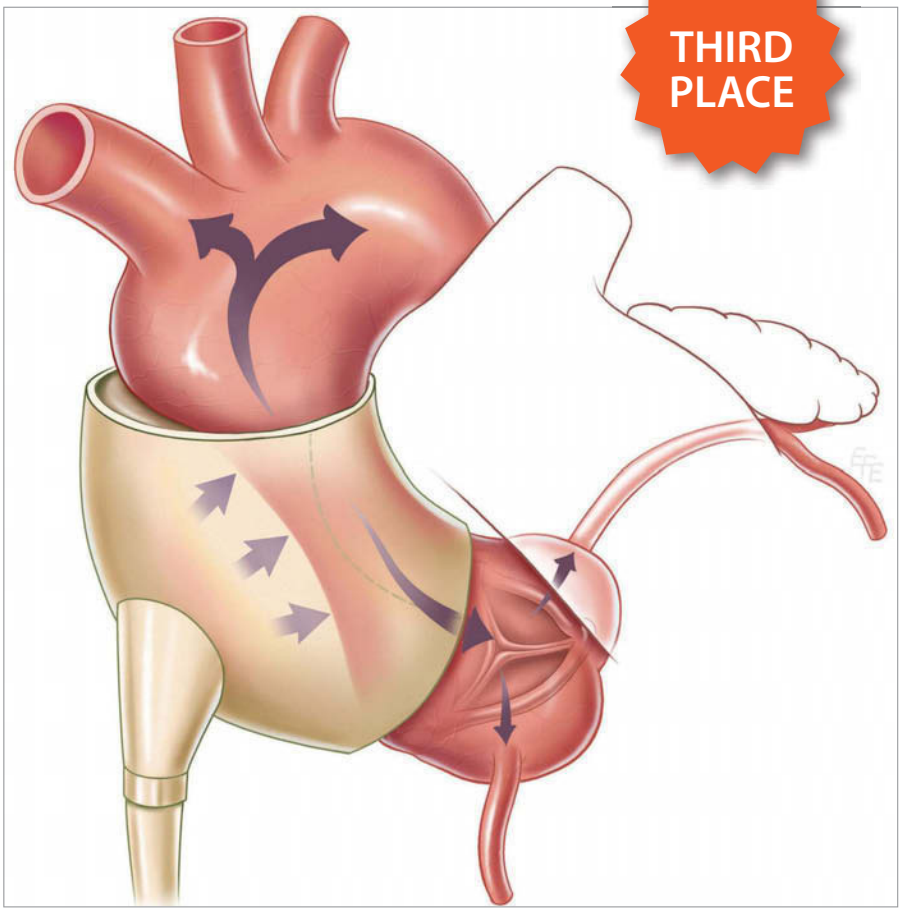


Figure 1: Sunshine Heart's novel C-Pulse heart pump design consists of a cuff that encircles the aorta, inflating and deflating to enhance blood flow and decrease the heart's workload.

About five million Americans suffer from the debilitating and progressive effects of heart failure, with 500,000 new cases diagnosed each year. The disease can result from hardening of the arteries, heart attack, high blood pressure, diabetes, heart muscle infection, lung disease, or valve disorders and can be fatal when the heart is unable to provide sufficient blood flow to the body.

Treatment for heart failure (HF) ranges from medicines to surgical repairs and from mechanical devices to transplants. And while no single therapy works for everyone, each has its side effects or risks. Dr. William Peters, a cardiothoracic surgeon and research fellow at Auckland City Hospital in New Zealand, thinks there must be a better way.

"I've always had a strong interest in devices to support the failing heart," he says. After commercial success with a minimally invasive bypass system he invented, Peters turned his efforts to a device less invasive and more reliable than exist-

ing technologies. "I was looking for a device that would not involve contact with the blood."

At the time Peters began designing, common implanted devices such as left-ventricular assist devices—while lifesavers for people awaiting transplants or recovering from open-heart surgery—involve surgical connection with heart and arterial tissue and require patients to remain on blood thinners, raising the possibility of bleeding and stroke. Reliability has been also been an issue with some heart-assist devices.

Peters determined that his device would work inside the body but outside the bloodstream. It is called the C-Pulse and consists of a biocompatible polymer cuff that wraps around the aorta (the

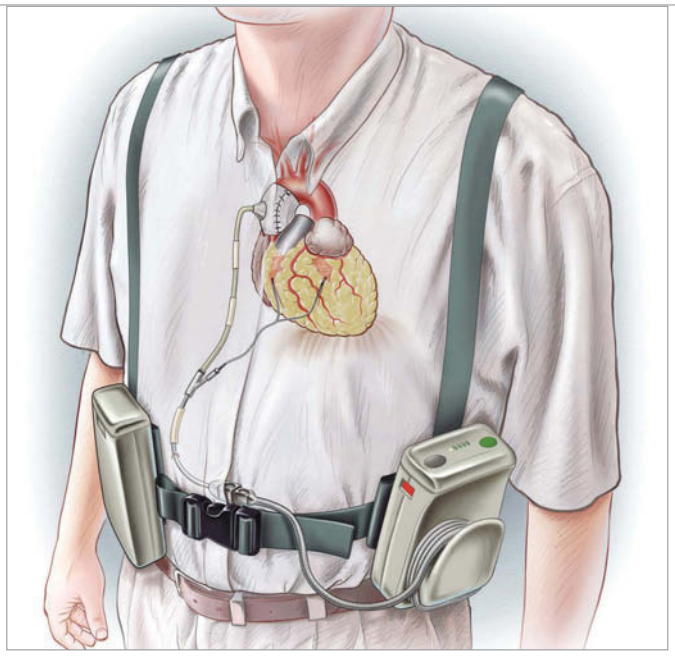


Figure 2: Patient wearing the C-Pulse System. A lead from the external power source [Driver] connects to a catheter inside the body attached to the implanted device [Cuff], which is wrapped around the exterior of the heart's ascending aorta.

main blood vessel that carries oxygenated blood from the heart to the rest of the body); it contains a balloon that inflates and deflates against the vessel's external wall (*see Figure 1*). The positive and negative pressure of the balloon make the aorta pulsate in time with the heart, augmenting blood flow through the circulatory system and reducing strain on the diseased heart. A battery-powered pump worn outside the body provides power (*see Figure 2*).

Peters patented his pump idea and formed a company, Sunshine Heart, to develop and test the device, initially on the bench and then in sheep. But once animal trials were successful and the device was ready to be scaled up to a human model, the company decided it needed a more sophisticated approach to the design and development process than the empirical, build-and-test approach they'd been using. The goal was not only to reduce lead-time, but to ensure that long-term performance would satisfy established product requirements for the medical device industry.

FEA optimizes fatigue performance

"The average human heart rate of 80 beats a minute equates to 42 million inflation cycles a year," says Scott Miller, manager of mechanical engineering at Sunshine Heart. "The accumulated stress, especially on a polymer, was the design challenge, and C-Pulse is essentially a permanent implant. To ensure that our physical design solution was optimized to give us the long-term fatigue performance required, we decided to look at it... using finite element analysis."

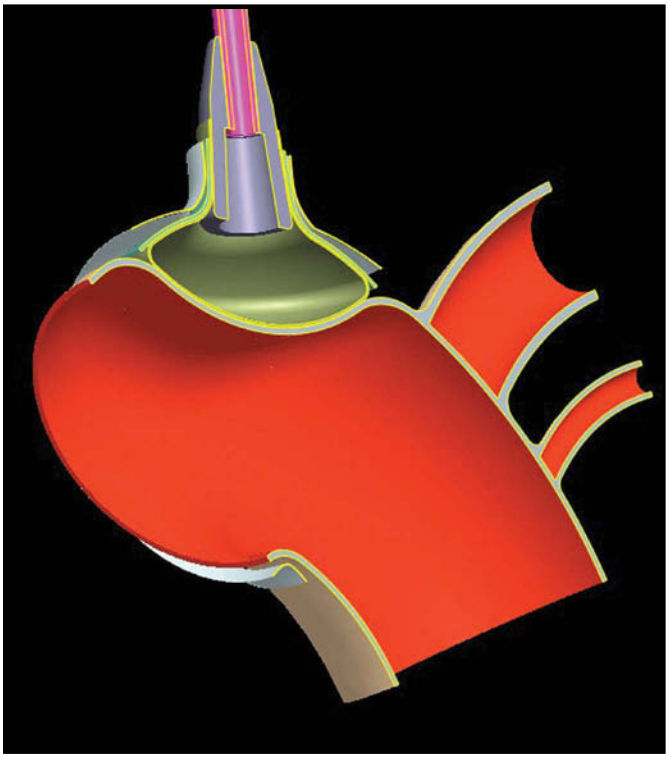


Figure 3: Pro/Engineer Geometry of C-Pulse unit on which Matrix's Abaqus FEA models were based.

Miller and his product development team worked with Matrix Applied Computing Ltd. of New Zealand for its technical software services. Matrix used Abaqus/Standard simulation software from SIMULIA to model the behavior of the C-Pulse cuff and balloon interacting with the aorta.

"The FEA analysis was an iterative process that required some very unique approaches because of the way our device worked, the materials we were using, and how the device is actually assembled," says Miller. The balloon had to be easy to manipulate during implant surgery; conform to the shape of the aorta; have the strength and flexibility to "snap through" from concave to convex and back again repeatedly; compress the artery; and perform reliably from initial inflation through

years of use—all within a very limited space. The goal of the FEA modeling was to accurately represent the real-world behavior of the device in order to guide design decisions and optimize the C-Pulse's performance through every stage of this process.

Element & materials choices are critical

As a starting point for the FEA analysis, Sunshine Heart provided Matrix with concave and convex PTC Pro/ENGINEER models of the device (*see Figure 3*).

According to Don Campbell, principal engineering analyst for Matrix, "It was an interesting challenge. Our analysis involved modeling hyperelastic material; a fabric membrane; simplified biological material for the aorta; contact, large strain, and a staged assembly process."

To determine the correct elements to use for modeling the artery, cuff, and balloon, Matrix created a series of test models. Quadrilateral shell elements turned out to be acceptable for the bulk of the parametric design studies (including determining the all-important optimum thickness of the balloon). But for modeling surface strains affecting the balloon in the fillet radius region (a critically important area where failures of the very earliest designs had occurred), hexahedron solid brick elements were chosen for more precise results using substructuring techniques with results from the shell model driving the solid element analysis.

The material-modeling portion of the analysis was constrained by physiology and anatomy studies that had already been conducted. "We were given pre-existing data for the biocompatible material (a polymer approved for medical device applications) from which the device would be manufactured," says Campbell. "The Ogden hyperelastic material model in Abaqus provided an excellent fit with the experimental data." The Ogden model is often used to model rubber-like materials.

Modeling the "snap through" function

With the FEA models of the C-Pulse set up, Matrix ran simulations to determine what shape the device's balloon should be during surgical implantation (starting with a convex configuration turned out to be most effective at minimizing strain). Next they simulated the complete balloon "snap through" motion of convex to concave and back again.

"The complexity of the analysis was less in its geometric difficulty or problem size, but more in the simulation of the continuous, alternating process," says Campbell. "The strain on the balloon varied from the outer to the inner surface of the material as it snapped through, so the total strain we were analyzing was a combination of stretching and bending. During the simulation cycle, the location of peak strain in the fillet actually moved from the minor to the major axis of the oval-shaped balloon."

Matrix ran its simulations as quarter models, using the assumption of symmetry to cut down on processing time and aid solution convergence. "There were some approximations with the quarter model since an aorta is not a straight pipe, but has some curvature," Campbell says. "However, for the

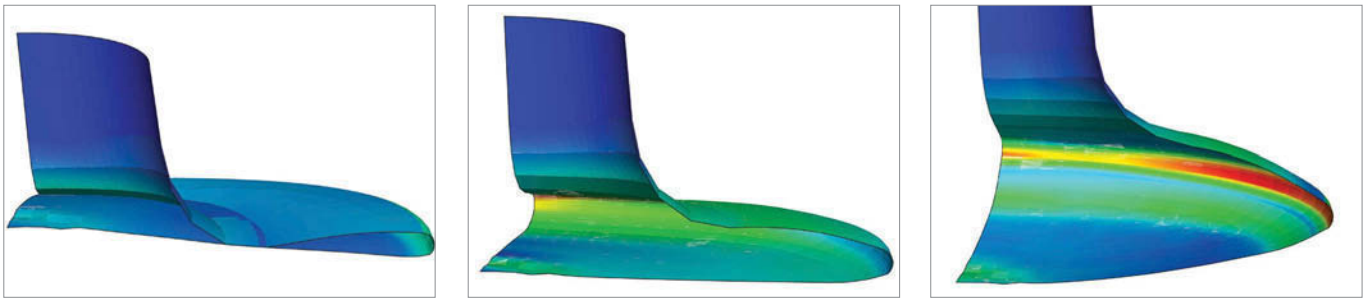


Figure 4: This series of images shows an Abaqus FEA strain analysis of the "snap through" of a C-Pulse balloon membrane. Note how the area of maximum strain (red) moves from the short axis (upper right images) to the long axis of the oval balloon (final image at bottom) from start to end of the cycle.

purpose of optimizing the design, the lack of true quarter symmetry was thought to have a minimal effect on the ultimate design parameters. This approach also let us perform a large number of parametric runs in a reasonable amount of time."

The ultimate goal of the FEA analysis was to arrive at a device shape with the least variation of strain amplitude and the maximum mean compressive strain during an operational cycle. Says Campbell, "It was a project with interesting physics and the final model we came up with has performed very well in the test environment."

FEA provides final design solution

The FEA models more than met Sunshine Heart's requirements. "We arrived at a design solution the first time through and haven't needed any additional FEA since then," says Miller. His group has subsequently proven that the solution holds true for different sizes, allowing for tailoring the device to individual patients.

And the durability of the C-Pulse design is being borne out by ongoing testing, Miller notes. "We have been running devices day and night literally for years now: the test machine requires regular maintenance because the C-Pulse keeps wearing the test unit out."

Sunshine Heart has used the device in human trials conducted in Australia and New Zealand and received conditional approval from the U.S. Food and Drug Administration to begin the clinical trial for C-Pulse, heart-assist therapy. It is expected that the company will enroll up to 20 patients in the U.S. suffering from moderate heart failure for further evaluations. ■

Lynn Manning *is a science and technology writer based in Providence, RI. You can send comments about this article to DE-Editors@deskeng.com.*

FOR MORE INFO:

> PTC

> SIMULIA

> Sunshine Heart, Inc.

COMSOL Multiphysics Models Hybrid Locomotive

> GE jumps on the green train by modeling a battery with COMSOL Multiphysics.

BY PHIL BYRNE

General Electric's Ecomagination technology is exemplified by the Evolution Hybrid Locomotive driven, in part, by batteries developed with the help of COMSOL Multiphics simulation software.

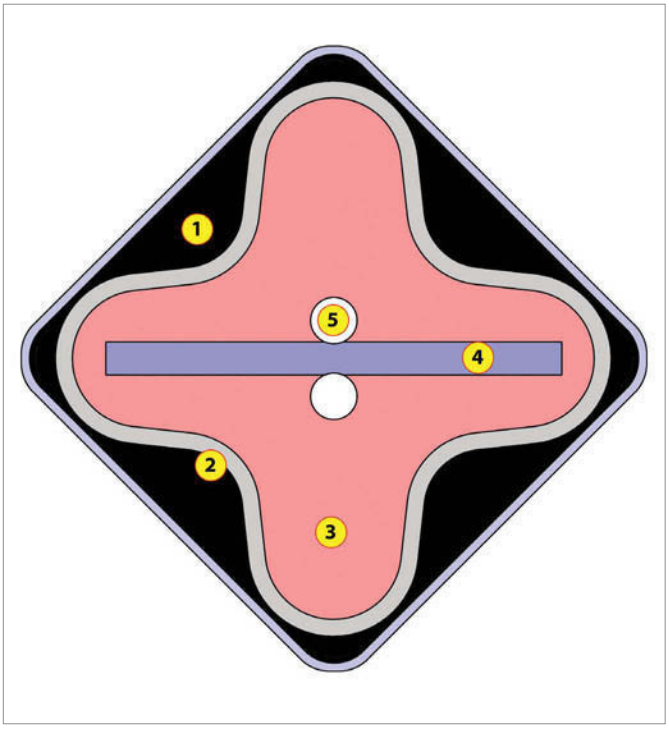
If all diesel electric locomotives in the U.S. were converted to hybrid technology, more than $425 million per year in fuel costs could be saved. Add this to significant cuts in greenhouse gas emissions (the reduction in one locomotive in one year would equal the emissions of 2,600 cars) and the environmental savings of General Electric's Hybrid Locomotive help move us toward a greener tomorrow as the economic savings help the bottom line of rail companies.

For years, fuel cells had been pushed as the answer for "green" transport even though a commercially viable vehicle was never fully realized. Rather than waiting for a hydrogen economy to be established, hybrid cars such as the Toyota Prius, Ford Escape, Chevrolet Malibu, and others have shown that a simpler and better use of existing technologies can also lead to substantial improvements in the environmental credentials of a vehicle. Best of all, they're available now.

Such vehicles, with their repetitive start-stop operation, are an application where hybridized internal combustion/electric drives are more efficient than internal combustion engines alone. But consumers of automobiles might not have suspected that a battery-driven electric locomotive would be practical. After all, a train moves heavy loads at fast speeds for long periods and over long distances. Surprisingly, though, batteries can make a substantial contribution to a train's power needs, given that they can provide up to 2,000 horsepower to a locomotive.

Recovered Energy Cuts Emissions

"One large difference compared to an automobile



A cross-section of the battery geometry and the various modeling domains: 1) Anode of molten sodium; 2) BASE of sodium conducting solid electrolyte (β" alumina); 3) Cathode of iron and molten-salt electrolyte (NaCl-saturated sodium tetrachloroaluminate (STCA)); 4) STCA reservoir; and 5) Cathode current collector.

is that locomotives spend many minutes while dynamic braking, rather than just seconds. This generates considerable energy that's normally lost," says Michael Vallance of GE Global Research. Vallance is simulating the sodium metal-chloride batteries that will drive GE's hybrid locomotives with COMSOL Multiphysics.

The plan is to make use of this braking energy to generate electricity in hybrid locomotives to achieve fuel savings of up to 15 percent, the equivalent of 25,000 to 30,000 gallons of diesel per vehicle per year or more than 300,000kg of CO2 emissions. Moreover, the reduction in NOx emissions is even more significant.

However, GE had to develop an alternate to the lithium and metal-hydride batteries used in passenger vehicles. They needed versions with higher energy densities to withstand the harsher environment of a long-haul locomotive. Furthermore, these new batteries must be tolerant of cell failures in high-voltage strings, where batteries with failed cells continue to operate safely and effectively.

To develop its own high-temperature sodium metal-chloride battery, GE formed a design team spanning its Global R&D laboratories, with members in Niskayuna, NY; Shanghai, China; and Bangalore, India. This team began a close collaboration with the engineers of GE Transportation in Erie, PA. As a result, GE's battery technology has reached the stage where a full-scale prototype of an operational locomotive is being used to display the technology to potential customers. In fact, back in 2007, GE demonstrated its first working hybrid freight locomotive by piloting one to Los Angeles' Union Station with company CEO Jeff Immelt on board.

A Valuable Tip

Vallance and his colleagues began to look for a modeling software package that was well suited to simulating the electrochemical reactions, materials, and energy transport that make up the sodium metal-chloride battery to better understand the mechanisms that make it function. One option raised was the COMSOL Multiphysics software platform.

Vallance attended a COMSOL Conference in 2007 to learn more about the software. At the

COMSOL Multiphysics' ability to couple and solve them simultaneously was a key feature in the team's decision to use the software and led to development of an accurate and realistic battery model.

conference he also met one of the leading experts in electrochemical simulations, Dr. Ralph E. White from the Department of Chemical Engineering at the University of South Carolina. White was able to advise Vallance on how to include advanced electrochemical phenomena in his models.

To fully simulate the operational behavior of a sodium metal-chloride battery, you must involve multiple mechanisms. Electrochemical reaction kinetics as described by the Butler Volmer equations need to be solved at the electrodes, while the model must also consider the transport of ions to these electrodes through migration, diffusion, and convection. A number of participating materials change phase as a part of the battery's charging or discharging operations, and the corresponding kinetics must also be factored in. Furthermore, temperature plays an important role in many of the battery's physical characteristics, including ionic mobility and the species' phases, so operational temperatures must be held within a narrow range. Considering all of these factors, COMSOL

Multiphysics' ability to couple and solve them simultaneously was a key feature in the team's decision to use the software and led to development of an accurate and realistic battery model.

Understanding Leads to Design Changes

The models Vallance created have uncovered results that led to a heightened understanding of the battery. In the present version of the battery, the modelers have been able to identify areas of high current density, and this information was used to adjust manufacturing tolerances at critical regions. The model provided additional insights concerning convective flows in the cathode, which lead to an experimental investigation of modified geometries. The value of modeling even extends into operating issues. Plotting cell resistance versus depth of discharge (DoD–the extent to which the reacting materials in the battery are consumed) indicates when operators should start a recharging cycle. Because cell resistance starts to rise exponentially after about 60 percent DoD, a battery should not be discharged long beyond this point. COMSOL Multiphysics will also be useful for investigating other properties such as the battery's structural integrity due to vibrations and other duress it experiences in the locomotive.

By using COMSOL Multiphysics, Vallance's team hopes to show rail transportation companies how they can save even more in energy costs than first thought at the same time they help reduce emissions of toxic greenhouse gases. ■

A locomotive expends considerable energy when braking. In hybrid locomotives, this energy is harnessed and stored by batteries (C) and can be used as the primary source or as a supplement to the energy created by the engine.
Image courtesy of GE Transportation

Philip Byrne *holds a Ph.D. in electrochemical engineering from the Royal Institute of Technology, Stockholm, Sweden. He is quality manager at COMSOL. Send comments to DE-Editors@deskeng.com.*

FOR MORE INFO:

> COMSOL

> General Electric

NI's LabVIEW Enables Battery Testing Platform

> Bloomy Controls' Battery Management System is poised to change the world by enabling better electric and hybrid automobiles.

BY PETER VARHOL

While engineering innovation can be about breakthrough products and exciting solutions, it can also be about enabling important new technologies—technologies that will in fact change the world through their value in enabling new ways of working and living.

Bloomy Controls of Marlborough, MA, is making strides in the development of an enabling technology that makes it possible to test battery systems for electric and hybrid automobiles. In a world where green technologies are becoming critically more important in ensuring the future of the planet, that's no small feat. Because of its significance to the automotive industry, its contribution to enabling green technologies, and its unique design and simplicity, the Bloomy Controls Battery Management System testing platform is the winner of the IT and computing category of Desktop Engineering's Change the World Challenge.

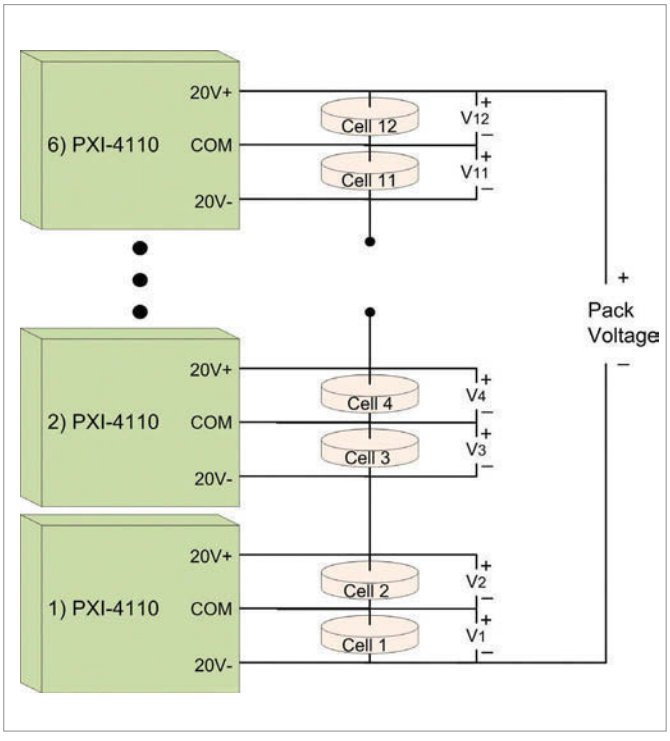
The rapid growth of the hybrid-electric vehicle industry has presented many new opportunities for product testing and measurement. Many of these opportunities require production-level test systems with short design times, high accuracy,

Bloomy Controls used LabVIEW to design its new battery management system.

and strong reliability. One opportunity, identified by Bloomy Controls, involved the production testing of battery management systems (BMSs) for lithium-ion battery packs used in plug-in hybrid electric vehicles.

BMSs handle all of the monitoring, control, and safety circuitry and functioning of battery packs and battery control systems, including accurately monitoring battery cell charges, balancing voltages between cells to maintain a constant voltage across packs, managing charging and discharging, and protecting the system from over-voltage and over-current conditions for packs of up to 12 battery cells in series.

In addition, BMSs monitor battery and support system temperatures, handle system power management by engaging in sleep modes to reduce current draw, and communicate with external controllers to provide system feedback. While there are several types of battery management boards, including individual pack balancing and monitoring boards and system control boards, they can all be considered BMSs for the purposes of the Bloomy Controls testing platform.



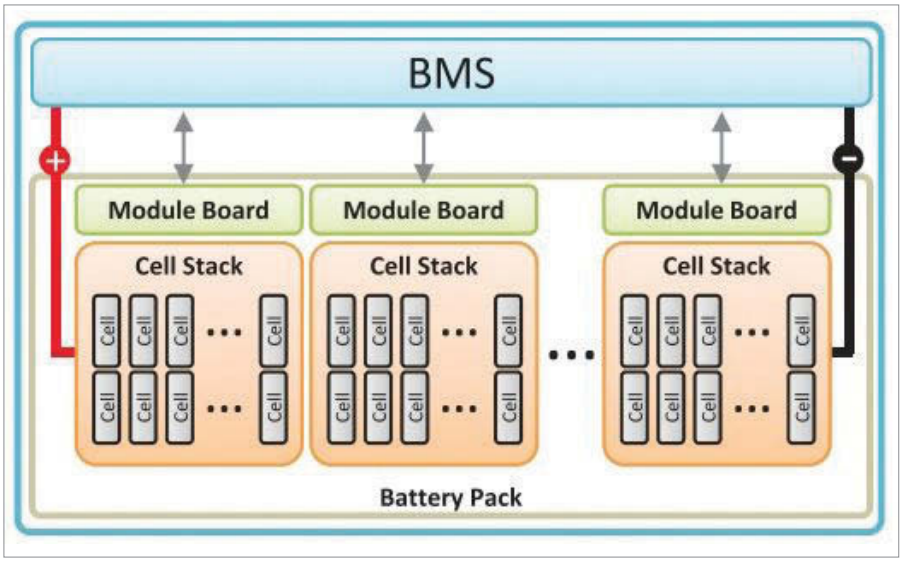
This setup shows a system built around six NI PXI-4110 programmable DC power supplies.

The BMS testing platform has to be able to simulate loads and stresses that are typical of what an automobile might do during the course of operation.

One key with the Bloomy Controls Battery Management System tester is that it is able to simulate a set of loads as a part of the testing process. This is an essential feature, as it is not possible to test battery systems in a manufacturing environment with actual automobiles. In fact, in some cases the target vehicle might not even exist yet; it might still be in the design phase, and need a BMS as an integral part of the design. The BMS testing platform has to be able to simulate loads and stresses that are typical of what an automobile might do during the course of operation.

According to Project Manager Robert Cornwall, the idea grew out of existing testing systems designed and built by Bloomy Controls. By moving into battery system testing, the company has been able to leverage existing skills and technology into an important piece of relevant technology.

The BMS testing system (they don't have a really catchy name for it) provides for the ability to



The Bloomy Controls BMS block diagram illustrates the modular approach to testing battery cells (up to 12 per pack) in a series configuration.

test battery systems coming of of a production line, prior to their integration into the automotive systems. It ensures that manufactured BMSs can handle battery systems on electric and hybrid vehicles without failing.

The BMS testing system employs a user interface built using LabVIEW, a software package from National Instruments that provides the ability to graphically build both a user interface and a f ow for the testing process. LabVIEW enabled the rapid development of the user interface and underlying software in order to run and administer the system.

The Bloomy Controls BMS testing platform provides a way for manufacturers of battery systems for fully electric or hybrid automobiles to easily ensure that their products are fully tested, reliable, and ready to be used in vehicles. It is modular and adaptable to dif erent types of BMSs, enabling the company to quickly reconfigure as battery technology changes.

The BMS Testing Platform Details

The design of the testing platform started with the Bloomy Controls PXI-based universal test system. Using this platform, project engineer Grant Gothing explained that the design team produced a f exible, high-accuracy base platform consisting of a standard mass interconnect capable of testing multiple models of BMS circuit boards by using interchangeable fixtures. "We centered our system around six NI PXI-4110 triple-output programmable DC power supplies, which we used to simulate a pack of up to 12 lithium-ion cells," he described.

The design team also multiplexed a high-accuracy NI PXI-4071 digital multimeter (DMM) to measure voltages within the required millivolt specifications, and added an NI PXI-6221 M Series data acquisition DAQ module to provide analog outputs, TTL digital I/O, and higher-speed analog input measurements. The group implemented the NI PXI-6514 industrial digital I/O module to read switches and actuate fixture relays. In addition to the PXI hardware, the company used fixed power supplies and programmable high-voltage and high-current supplies to provide additional system power as required by the testing specifications.

Finally, the engineers provided a USB connection to the fixtures to allow f exible addition of other UUT-specific communications and peripheral hardware on a per-model basis. The design team

housed all of the hardware in a standard 19 in. rack. The test rack provided a system capable of making any measurement and supplying any source required by a BMS board.

As mentioned earlier, the software operating the BMS was written using the LabVIEW visual programming environment. It contained all test parameters in a configuration file to allow the customer to update, tighten, or loosen test specifications without making software changes. In addition, the group stored all of the data acquisition channels and tasks in a separate configuration file, which allowed hardware or wiring changes to be made without af ecting the underlying software.

By using a modular approach to design, along with interchangeable components, the base system can accommodate testing a wide range of BMS models, supporting many different potential battery and automotive designs.

Also, because the user interface is designed for a manufacturing environment, it requires minimal operator interaction. To operate, the test technician simply opens the safety lid of the fixture, scans the barcode serial number of the unit to test, then closes the fixture for the test to start during standard operation. When testing is complete, the test result is shown, test data is logged to file, and any failed tests are highlighted for the technician.

By using a modular approach to design, along with interchangeable components, the base system can accommodate testing a wide range of BMS models, supporting many dif erent potential battery and automotive designs. This method reduces cost and new fixture design time and makes it cost-ef ective to test even small quantities such as R&D prototypes. The NI PXI platform coupled with LabVIEW delivered the ideal tools to quickly design and build a BMS test platform that is f exible enough to test multiple customer products, and accurate enough to meet or exceed BMS testing requirements. ■

*Contributing Editor **Peter Varhol** covers the HPC and IT beat for DE. His expertise is software development, math systems, and systems management. You can reach him at DE-Editors@deskeng.com.*

FOR MORE INFO:

> Bloomy Controls

> NI

Hyperacuity Systems Uses LabVIEW for Vision

> Enabling moving robots and other devices to see and understand their environment is a highly difficult problem for which Hyperacuity Systems has an innovative solution.

SECOND PLACE

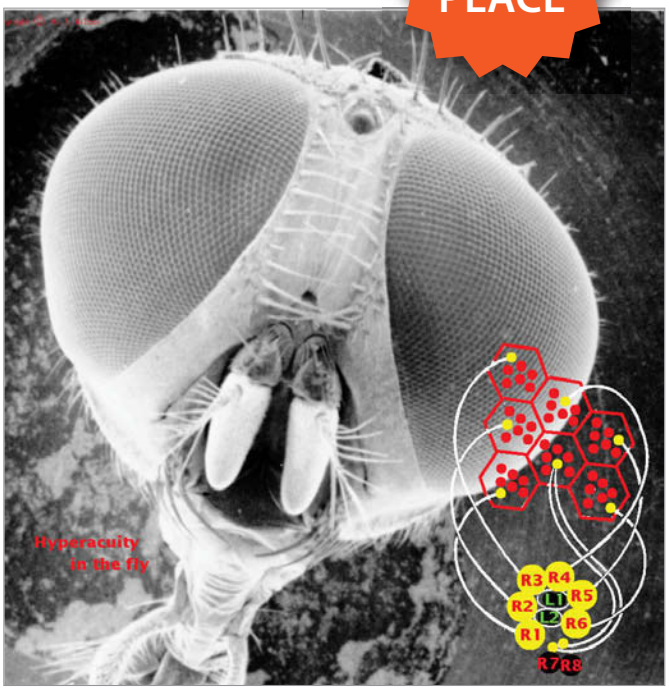
BY PETER VARHOL

Professor Michael Wilcox, owner and principal of Hyperacuity Systems, has always been interested in vision and visual systems. A biologist and biophysicist by education, his early work in ophthalmology resulted in the development of a medical device that allows glaucoma to be treated without drugs.

Wilcox has applied his expertise in vision systems to designing and developing cutting-edge technology in that area. His company, Hyperacuity Systems, has developed an instantaneous subpixel resolution camera that records images in real time. It is the fastest known camera in the world. Interestingly, studying the eyes of flies inspired the creation of this camera, which is targeted to robotics and vision systems.

Wilcox noted that most computer vision systems today sample the visual space using cinematography; in other words, digital film. These devices use high spatial resolution at high frame rates to enable machines to "see" and interpret moving images.

But it's not that easy. Most existing approaches require a great deal of computational horsepower, and result in a motion view that is not smooth and continuous. By the time a particular image has been interpreted in sequence, it may be too late to make the appropriate response.



Studying the eyes of flies inspired Wilcox.

Because Wilcox has the advantage of a deep understanding of human and animal vision systems, he has been able to apply some of those principles to creating an innovative machine vi-

sion system. Animal photoreceptors dif er from the monolithic pixel profiles in a camera and use an optical, nonlinear Gaussian approach. Animals are then able to encode subpixel resolution, enabling the brain to interpret images with higher resolution as well as data reduction.

The Hyperacuity Systems solution consists of modular elements with analog processing to extract a feature set from objects in an image, as well as a comparator mesh that connects the dots between elements. The result is an instantaneous vector output of both object position and motion from each element in the array.

The analog circuitry uses a logarithmic compression algorithm to get a high dynamic range and variable working range as animals do, enabling machines to see more like animals or humans do.

The implementation is a chip that can detect both position and displacement with hyperacuity, accuracy better than 1/10th the pixel size or spacing. In other words, this chip is able to extract and interpret more information from fewer pixels. To assist in the design, Wilcox and his team simulated larger arrays with National Instruments' LabVIEW, which demonstrated the ability to do faster processing.

The analog circuitry uses a logarithmic compression algorithm to get a high dynamic range and variable working range as animals do, enabling machines to see more like animals or humans do. The new approach provides better parallax and stereo imagery with reduced power consumption and faster processing. It results in better image interpretation and a faster response by the machine. It also works well under low lighting and contrast conditions, because of low-voltage dif erential sensing from photoreceptor elements in the same cartridge.

Wilcox hopes that this type of camera system can be used in high-speed manufacturing environments where fast product inspection is critical, as well as new automotive applications in collision detection and avoidance. Because of the speed of interpretation, this system can likely be used in any device that requires detection and interpretation of moving images. The camera and machine vision system is still in development. Expected release is in 2011. ■

*Contributing Editor **Peter Varhol** covers the HPC and IT beat for DE. His expertise is software development, math systems, and systems management. You can reach him at DE-Editors@deskeng.com.*

FOR MORE INFO:

> National Instruments

Mobile, Cloud-enabled Slate Pad Uses Intel Atom

> The Internet and Intel's Atom processor make possible a new type of mobile computer that depends on the cloud or the servers back home for its functionality.

BY PETER VARHOL

Kayvees Design Studio created the Slate Pad, powered with Intel's Atom processor.

We've all been concerned about losing our laptop when we travel. With airport security, work inflight, carrying the laptop around, and leaving it in the hotel room in the evening, there is ample opportunity. I once asked a TSA agent at San Francisco International Airport how many laptops got left behind in a day. The answer: 25 to 30.

While the laptop may be worth a few hundred dollars, the data is the real issue. There might be proprietary data on the system of value to someone else. Even if the hard disk is encrypted, the data is lost and it may be very time-consuming or even impossible to recreate.

In response to this very real problem, KayVees Design Studio has created a new type of personal computer system, similar to a netbook but still more basic. Called the Slate Pad, it provides a basic ability to connect to the Internet and download and run applications that can reside on enterprise servers or be rented or accessed from a location in a public data center as required.

The Slate Pad consists of a display, input and output (track pad, keyboard, and graphical display), Intel's Atom processor, support logic, memory, and wireless network access. You store your data in the cloud, open your files and applications, perform your work, and save that work back to the data center.

The operating system doesn't matter, as long as it can fit into the memory space. You can boot either Windows or Linux, but it has to be downloaded from the data center across the Internet. This provides the ultimate in flexibility, in that users can even rent the OS by the hour, depending on their application

requirements. The same is true with regard to renting applications; it's not common today, but it will likely become common in the future.

In addition to providing a solution to protecting data, the Slate Pad has the ability to become the computer for the masses. Similar to the One Laptop Per Child initiative, the Slate Pad is low cost and relatively low technology. As long as there are applications available on a server somewhere, the Slate Pad can stream them and run them locally, then save files back on the servers.

Still, the Slate Pad may be a little before its time. The cloud data centers are not yet in widespread existence, and wireless Internet access is neither free of charge nor widespread across the country or the world. This sort of computer may be the wave of the future as both a consumer device and a business convenience, but it's going to take at least several years for the data center and Internet infrastructure to be built out to support the concept. When it does, we may well be past the time where everyone has to have the latest and most powerful computer.

KayVees Design Studio is creating the Slate Pad for a computer manufacturer who wishes to remain anonymous at this time. The system is slated to be completed at the beginning of 2012. ■

*Contributing Editor **Peter Varhol** covers the HPC and IT beat for DE. His expertise is software development, math systems, and systems management. You can reach him at DE-Editors@deskeng.com.*

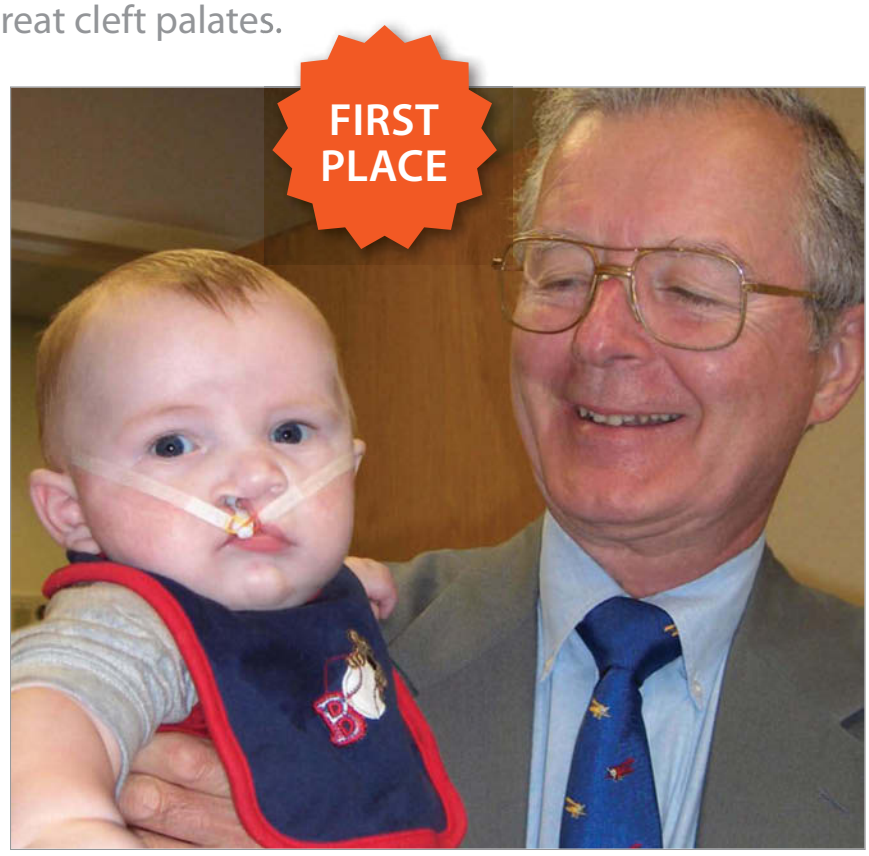
FOR MORE INFO:

> Intel

Using Geomagic Studio to Bring Smiles to Babies' Faces

> A new treatment from Shriners Hospital uses reverse engineering and rapid manufacturing to help treat cleft palates.

BY BOB CRAMBLITT



Dr. Philip Stoddard and his patient near the end of the presurgical treatment with the last of a series of treatment appliances designed using Geomagic software from scans of dental impressions.

Geomagic software has been used for everything from helping to ensure the safety of the space shuttle to making invisible aligners that take away the stigma caused by traditional orthodontic braces. But perhaps the most life-affirming application of Geomagic software has come out of an engineer-physician team working at Shriners Hospital for Children in Springfield, Mass.

The engineer, Beth Roscoe, and the physician, Philip Stoddard, are using Geomagic software to bring smiles to children's faces, and by extension, the faces of their families. With the help of 3D scanning technologies, Roscoe and Stoddard have developed a new treatment for severe cleft lip and palate that reduces the cleft width before surgery without inhibiting upper-jaw growth.

Like many breakthroughs, this one came through a combination of vision, innovation, great technology, and a fair amount of luck. The good fortune

Like many breakthroughs, this one came through a combination of vision, innovation, great technology, and a fair amount of luck.

came from a chance encounter in a hospital cafeteria, and the friends Stoddard has made through his hobby, f ying gliders.

Searching for a Better Way

The search for a new treatment began a few years ago after Stoddard returned from a workshop on Naso-Alveolar Molding (NAM)—one of the two major presurgical treatment methods for babies born with severe cleft lips and palates.

NAM is labor intensive and requires a dental lab and onsite orthodontic staf . Results can vary depending on the skill of the orthodontist administering the treatment. The other treatment method, DentoMaxillary Appliance (DMA), also has drawbacks. It is invasive, requiring surgical pinning of an appliance to the roof of the mouth under anesthesia, and daily screw tightening by caretakers. Some physicians think it might also impede jaw growth.

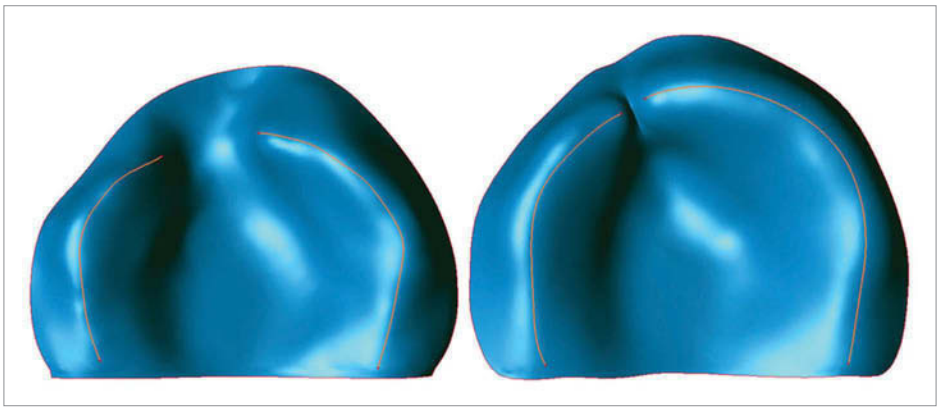
Stoddard thought there must be a better way. He believed that computers might be the key to better presurgical treatment for wide cleft lip and palates, but he didn't know about the technology to make it happen. That's when the first bit of serendipity took place.

Prosthetics researcher Beth Roscoe and surgeon Dr. Philip Stoddard of Shriners Hospital for Children with dental impressions of one of the first patients to receive the new treatment centering around non-invasive appliances modeled with Geomagic software.

Stoddard was having lunch in the Shriners Hospital cafeteria when he had a chance meeting with Roscoe, a resident in prosthetics. During the course of their conversation, Stoddard learned that Roscoe was previously a software engineer who developed CAD systems.

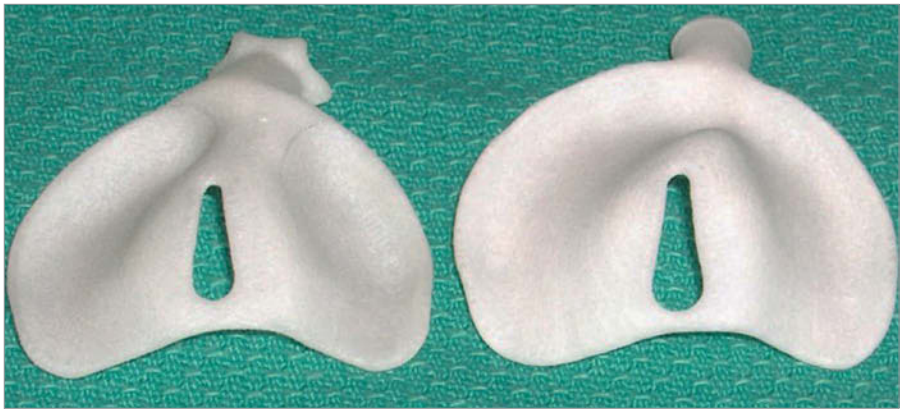
A New Methodology Takes Shape

A light bulb went on in Stoddard's head. He asked Roscoe to develop a proposal for using CAD/CAM for presurgical treatment of cleft lip and palate. She accepted the challenge.



A close up (at right) of the occlusal view for the first and last appliances modeled in Geomagic software.

The RP-manufactured first and last appliances (below) in a treatment series modeled with Geomagic.



Roscoe proposed scanning a plaster model of a patient's cleft palate to obtain 3D shape data, modeling a corrected palate, interpolating between the model at the beginning and the end of the treatment to reduce cleft width while accommodating for growth, and then using a rapid-prototyping machine to produce a series of corrective appliances.

"The serial appliance approach was a way to circumvent the need to modify a single appliance every week," says Roscoe. "Each appliance in the series would represent the manual modification used in the other methods. I knew it wasn't an A-to-B linear path of treatment. The appliances needed to morph to accommodate changes in size, shape, and even configuration."

Right Tool at the Right Time

With the procedure outlined, the main issue was choosing the software for 3D modeling. Roscoe thought she might have to use the scan data as a reference and create the CAD model from scratch.

She gave the proposal to Stoddard, who ran it by Peter Fuss—an electrical engineer, fellow glider enthusiast, and friend—during a ski vacation. Stoddard didn't know at the time that Fuss was on the Geomagic board of directors. Fuss thought that Geomagic would be ideal for the project. After the vacation, Fuss arranged for Roscoe to obtain Geomagic Studio, and she began learning how to use it.

"I didn't have any formal training," says Roscoe. "I muscled through and got a good command of the software on my own, with the help of some online tutorials from Geomagic." Her initiation with Geomagic confirmed what Fuss had suspected.

"Geomagic was the perfect solution to our very specific need: to be able to create and easily manipulate detailed 3D models from point clouds," says Roscoe. "It enables us to produce highly accu-

rate appliances that provide a custom-fit for each baby, and a means of specifying each patient's unique 3D prescription."

Putting It All Together

The final piece of the puzzle—how to manufacture the series of individualized appliances—involved Bob Morehardt, another of Stoddard's technology-minded glider friends.

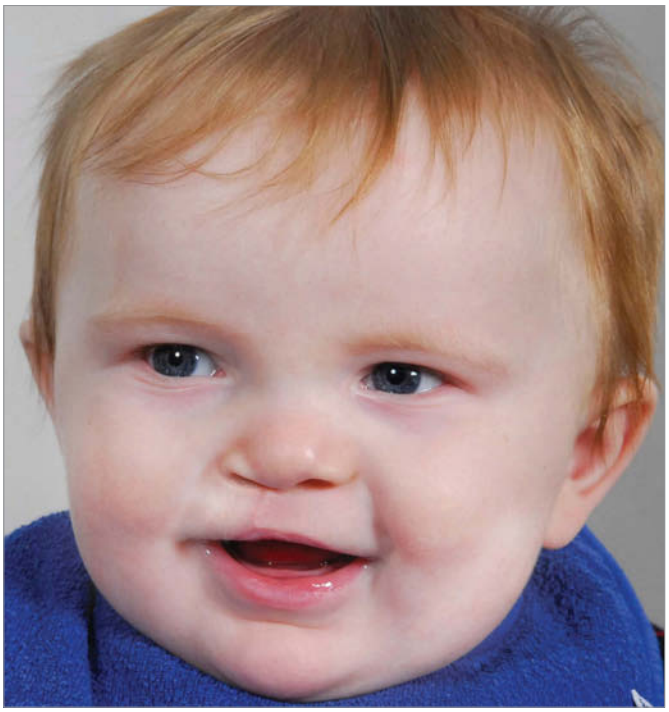
Although Stoddard didn't know it when they first met, Morehardt is owner of RMB Tool (formerly Mor-Tech), the first rapid prototyping service bureau in the Northeast United States to use selective laser sintering (SLS) systems. When Roscoe found out about Morehardt, she thought he could provide the manufacturing part of the solution.

Roscoe and Stoddard met with Morehardt and came away confident that they could use RMB Tool's SLS systems from 3D Systems to create the dozen or more appliances needed to serially mold a patient's gums into a more normal position, while allowing the palate to grow naturally.

After outlining the treatment methodology and determining the technology tools, it was time to put the new regimen to the test. This required permission from the Institutional Review Board (IRB), the medical equivalent of the Federal Aviation Administration (FAA).

The Proof is in the Smile

The IRB approved the Roscoe-Stoddard plan and treatment for the first baby began in early March 2008. The procedure is fairly simple. Roscoe establishes the initial palate shape by scanning a mold of the child's lip and palate. Initially a CMM



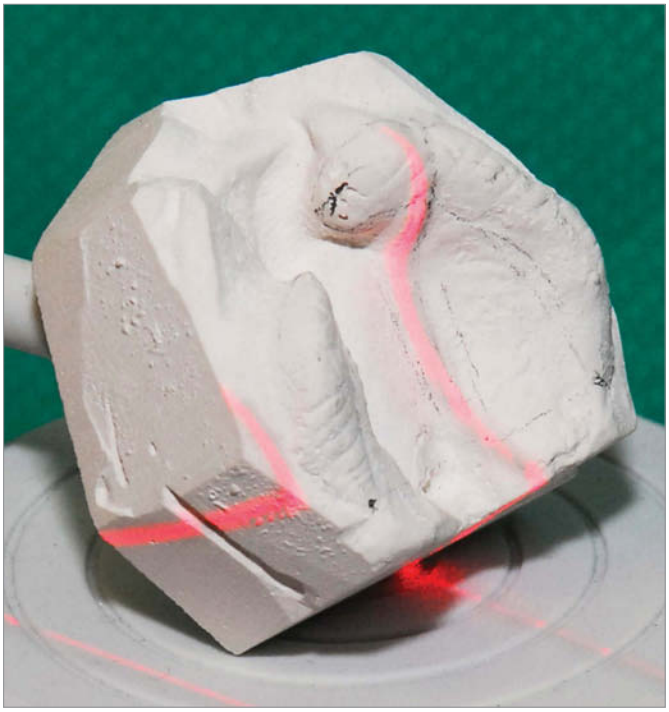
This is the happy patient two months after his cleft palate surgery.

system was used for this; now Roscoe uses a ShapeGrabber 3D laser scanner for data capture. Within Geomagic, Roscoe defines the desired final palate shape (allowing for growth), creates the intermediate steps, and converts each pal-

Two babies have so far completed the process. Treatment was tolerated well in both cases and the physical transformations are stunning.

ate shape into a digital model of the appliance at the dif erent intermediate steps. Finally, the series of appliances is manufactured with an additive system.

Treatment typically begins within the first



Scanning of the dental impression of the cleft palate.

month of the baby's life and lasts 10 to 15 weeks, after which lip repair surgery is performed by the plastic surgeon. Two babies have so far completed the process. Treatment was tolerated well in both cases and the physical transformations are stunning.

Besides the dramatic differences in physical appearance, other benefits of the new procedure are that it is less invasive (appliances are not pinned to the roof of the mouth); it is less labor intensive; there's no anesthesia risk for appliance insertion (anesthesia is not used); software enables more control in sculpting the corrected palate and gum shape prior to lip repair; and it is an accurate, repeatable process.

"The treatment couldn't have gone any better," says Rose Kellogg, grandmother of the second baby treated. "We wanted something less invasive and this was perfect. He is sensitive but he got through it nicely. He was treated as an individual and our whole family was given special treatment by everybody at Shriners Hospital."

The new presurgical treatment offers a couple of important precedents from a physician's perspective.

"Never before have we been able to accurately accommodate the baby's growth as part of presurgical treatment," says Stoddard. "And, for the first time, we can offer a less-invasive treatment without the need for onsite orthodontic staff."

Roscoe and Stoddard hope to make the new methodology available to other cleft clinics in the future. There's also great potential for using the process in other areas of orthopedic and reconstructive medicine.

"Physicians that have been introduced to the capabilities of Geomagic have a new perspective in problem-solving," says Roscoe. "I believe we are just scratching the surface of how this technology can be used to help patients in a wide variety of ways. It's very exciting!" ■

Bob Cramblitt *is principal of Cramblitt & Company (cramco.com) in Cary, NC, and writes about design, engineering, and IT technologies. Send e-mail about this article to DE-Editors@deskeng.com.*

FOR MORE INFO:

> 3D Systems
> Geomagic
> ShapeGrabber
> Shriners Hospital for Children

Mimics Revolutionizes Life-Saving Device and Therapy Development

> Materialise's MIS helps doctors and designers get a better view of the human anatomy.

SECOND PLACE

BY COLLEEN WIVELL

The Mimics interface shows a segmented model of a patient's CT scan with the AbioCor artificial heart (in yellow in the scan and inset lower left) in position.
Image courtesy of Abiomed, Inc.

When a person's heart fails or someone needs a stent to improve cardiovascular health, it's often difficult to figure out what treatment is best or know exactly where a medical device should be placed. Unlike a car with a hood, the human anatomy is not immediately accessible. To solve that challenge, Materialise developed the Mimics Innovation Suite, which links CT and MRI data with rapid technologies, FEA, CFD, and CAD.

The Mimics Innovation Suite enables the visualization of a patient's anatomy so medical engineers, researchers, and doctors can design patient-specific medical devices, understand what treatments will work best, and know exactly where to place lifesaving and life-improving appliances. It enables them to visualize the previously invisible, and engineer directly with anatomical data.

For these reasons, *DE*'s judges picked the Mimics Innovation Suite (MIS) as the second-place winner in the rapid technologies division of DE's Change the World Challenge. The suite is comprised of Mimics and 3-matic software as well as engineering

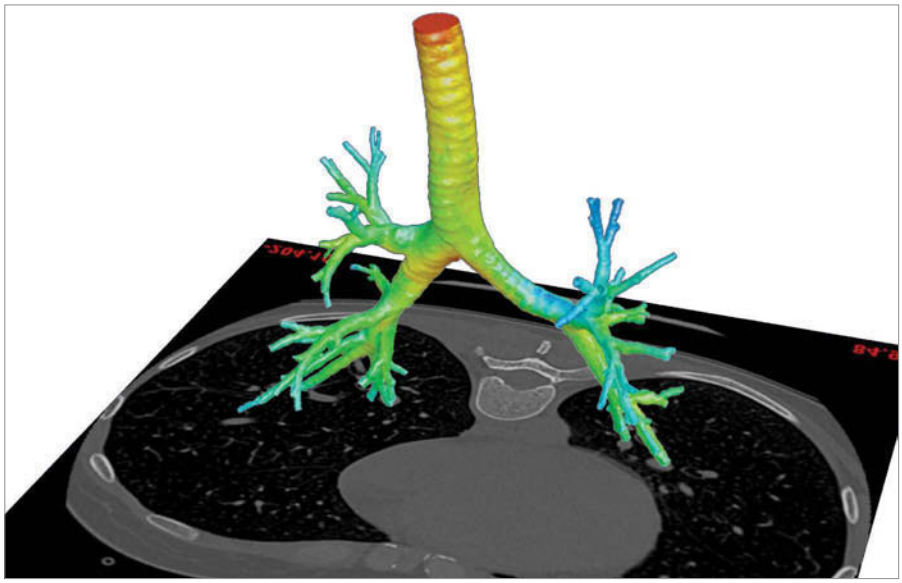
services. Mimics makes it possible to construct a 3D model based on CT scan or MRI data, enabling engineers and doctors to study specific internal human anatomy in a non-invasive way. It outputs STL files that are then used in 3-matic for patient-specific measurements and analyses, custom implant designs, and surgical guide designs.

3-matic is the company's program dedicated to working on anatomical data, a bridge to CAD or CAE. A variety of design and meshing operations can be performed directly on the imported 3D anatomical data generated in Mimics. Thus, the software eliminates the lengthy and error-prone process of reverse engineering. However, if the user needs to export the selected anatomical data or the design to CAD, then 3-matic's automatic reverse engineering capabilities can speed up and simplify the process. 3-matic is designed to interface with Mimics seamlessly and allows export to any CAD program and all major CAE packages.

MIS has inspired top researchers around the globe to take their research to the next level, including pulmonary and cardiac R&D. Dr. Jan De Backer, CEO of FluidDA, and his team have been using the Mimics Innovation Suite to generate patient-specific airway models for airflow simulations (also for cardiovascular modeling). The models

allow the team to assess the efficacy of a certain treatment (e.g., virtual stent implantation, inhaler delivery systems), eliminate treatments that don't work, improve respiratory medical treatments, and design patient-specific devices.

Dr. Robert Kung, chief scientific officer of Abiomed, Inc., used MIS to calculate the distances between the cardiac inflows and outflows of numerous patients. From this data, Kung and his development team were able to design an artificial heart, the AbioCor, that would fit the greatest number of patients. Today, Kung's team continues to use the software suite to determine whether a patient's unique anatomical structures can accommodate the AbioCor and if they are a good candidate for the replacement heart.



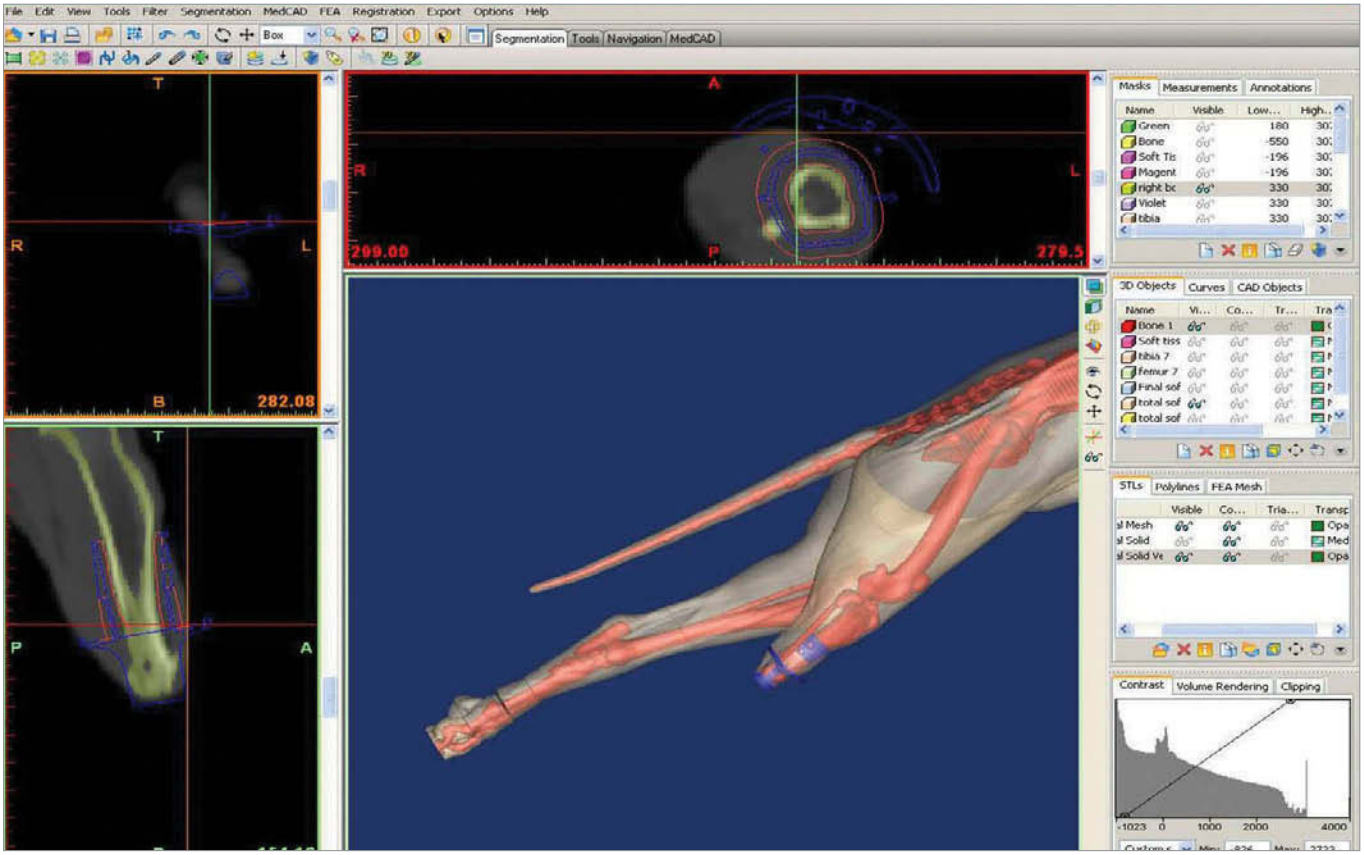
Segmented human airway colored according to total pressure. CFD calculations illustrate pressure distribution on the wall generated by the airf ow through the model. *Image courtesy FluidDA*

Nearly all major implant manufacturers are using MIS to design custom implants in the craniofacial and orthopaedic markets.

Dr. Ola Harrysson, an associate professor at North Carolina State University (NCSU), teaches students in his biomodeling course how to use the Mimics Innovation Suite. During class, students design and print custom osseointegrated prosthetic limbs for disabled cats and dogs using Materialise software and Electron Beam Melting (EBM) technology. Though custom implants made via standard means are already available for humans, NCSU is collaborating with an orthopaedic group at Duke Medical Center to bring their unique process to the market.

Similar to Dr. Harrysson's research, nearly all major implant manufacturers are using MIS to design custom implants in the craniofacial and orthopaedic markets. An implant that is designed using patient-specific data will fit optimally, reduce operating-room time, improve implant longevity, and enable faster patient recovery times.

Materialise takes it one step further with their clinical software packages (SurgiCase CMF (cranio-maxillofacial) and SurgiCase Orthopaedics) which allow surgeons to define a virtual surgery plan based on patient CT or MRI data. SurgiCase software can be used to simulate osteotomies



Mimics interface showing a segmented bone and soft tissue model of a dog with measurements of the dog's leg and implant for a prosthesis. *Image courtesy of North Carolina State University*

and evaluate implant size and placement. Once a plan is approved, a Materialise surgical guide is used to transfer the plan to the operating room with the utmost accuracy. Through this process, OR time is reduced and patient outcomes are improved. Although Mimics has been commercially available for 15 years, the Mimics Innovation Suite was launched in 2009 to provide doctors and biomedical engineers with a total solution. Since then, these doctors and designers have acted as pioneers in developing ways of using Materialise solutions for biomedical applications, moving rapid technologies into the realm of world-changing advancements where the possibilities are endless. ■

Colleen Wivell *is general manager of Materialise USA. She has a BS in mechanical engineering with a minor in biomedical engineering from Carnegie Mellon. She started her career as a design engineer at Ford and joined Materialise in 1998. You can send comments about this article to DE-Editors@deskeng.com.*

FOR MORE INFO:

> Abiomed, Inc.
> FluidDA
> Materialise
> North Carolina State University

Skywalker Air Vehicle Built by Z Corp Printers

> Mirror Image Aerospace uses 3D printing for the prototype of its new VTOL vehicle.

THIRD PLACE

BY PAMELA J. WATERMAN

The 2005 Skywalker vertical take-off and landing aircraft quarter scale model stands about 24 in. high. All parts are made from advanced composite graphite materials.

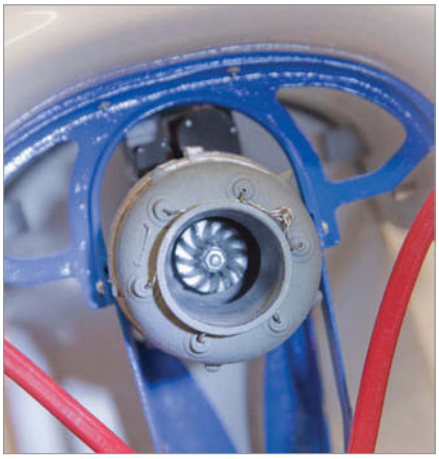
Even if you didn't grow up watching the Jetsons zoom to school, work, and shopping in personal flying machines, you can understand the appeal. Who wouldn't want to rise above traffic jams: soar over highways, bypass stoplights, and arrive at anywhere in a tenth of ordinary earthbound commute-time?

Designers at Mirror Image Aerospace of Ogden, Utah, have spent more than a decade working on just such a concept called the Skywalker Vertical Take-Off and Landing (VTOL) personal air vehicle. Thanks to improvements in rapid technologies, solid modeling, and computational fluid analysis, the design has continued to evolve, but the basic concept relies on a pair of fixed, counter-rotating turbine-style propellers within a shrouded-intake air duct.

Mirror Image Aerospace's first Skywalker prototype in 2000 relied upon conventional materials and assembly procedures. The design changed and in 2007 the use of rapid parts fabrication became the key to creating an affordable, quarter-scale model. Company CEO Kent Crookston, a composites expert and 30-year aviation-business veteran, has used a Z Corporation 310 3D printer for five years. He was familiar with its powder-matrix operation and knew it could generate parts with the necessary level of detail.

The team built a quarter-scale model of the complete engine, counter-rotating blades, hubs, spinner (cap) on the hubs and transmission mount

Top view of the counter rotating blades. There are two, f ve-bladed hub assemblies and a cone-shaped spinner cap.



This is a quarter-scale model of a Solar T-32 turbine engine. Air duct supports are painted blue. The turbine engine and air duct structures were manufactured on the Z Corp 310 3D printer.

using Z Corp's gypsum material. The parts cost considerably less than they would have if manufactured using stereolithography, and were easily painted or reinforced with fiberglass epoxy.

For larger parts such as the actual body, wings and landing gears, Crookston spent months building mold patterns manually. For many of the other parts, he feels he could not have accurately produced them without 3D printing. He says, "The counter-rotating blades had to be opposite, mirror images, which would be very difficult to make by hand."

Mirror Aerospace is now on a fast track to get in the air. This past year's efforts have resulted in a top-to-bottom redesign based on CFD analysis results, and for weight-savings the Skywalker will use composite materials as much as possible. The new vehicle features a wider fuselage, two-passenger capacity, and improved aerodynamics. Construction of the working prototype begins in February 2010. So far the project has been self-funded, but Mirror Aerospace is happy to talk with interested parties.

Skywalkers are designed to be kit-built, and for now, require a pilot's license, but thanks to 3D printing, the day of Jetson-craft for all of us is coming closer. ■

*Contributing Editor **Pamela J. Waterman**, DE's simulation expert, is an electrical engineer and freelance technical writer based in Arizona. You can send her e-mail to DE-Editors@deskeng.com.*

FOR MORE INFO:

> Mirror Image Aerospace

> Z Corporation

Full-Scale Folding Bike Built on Solido SD300

> > Working model created by Ziv-Av Engineering for demo wins investment funding.

BY PAMELA J. WATERMAN

The three main sections of this folding bike were built on a Solido 3D SD300 desktop printer and painted to look like metal.

No one is sure who invented the bicycle, but by 1893 an American was issued a patent for a folding two-wheeler design and in 1896 a French military version followed suit. During World Wars I and II, thousands of British military folding bikes were in use, and now more than a hundred manufacturers produce their own interpretations.

Folding bikes fill a growing need for transportation options beyond traditional designs. With a frame that generally doubles up on itself, folding bikes fit in the trunk of most cars and behave like a piece of luggage on a bus or subway, in an office, dorm, or apartment. In spite of the competitive market, there's always a drive toward less weight and better handling.

This new folding bicycle concept first saw the light of day on an Israeli reality-TV show based on Japan's "Dragons Den" investment concept. The program matches up inventions with investors and in Israel goes by the undeniably striking name of "The Sharks." Would-be inventors get four to five minutes to present their product's concept and business plan before getting the thumbs up or down for funding.

Traditionally such bicycles fold in half like a

book closing, with the front wheel swung to right or left to meet the rear tire. The key to this new design is a central pivot structure. Here the front wheel swings up and back toward the rear section more like folding a classic Swiss Army knife for a more compact profile. For the show, the company needed a full-size working bicycle tough enough to be put through its paces.

An Israeli product development company, Ziv-Av, took on the job and selected the Solido 3D SD300 printer to create quick but durable parts from layered sheets of SolidVC, a rigid PVC-based material that can be machined, painted, and finished.

The entire bicycle was assembled in less than five days, at a cost savings of two to two-and-a-half times over outsourcing the parts to a traditional machine shop.

The inventors tasked Ziv-Av with building the three main sections of the bike frame plus the folding mechanism. Engineers broke down the frame design into six parts comprising 14 total pieces. At 22 inches long, the top tube was the largest final part. The folding mechanism involved about a dozen smaller pieces and all were assembled into final parts with commercial adhesives.

Building the sub-sections on the SD300 system required just four separate runs. The parts came together quickly and were a suitable simulation of cast aluminum; assembly used standard nuts, bolts, bearings, cables, and gears. The entire bicycle was assembled in less than five days, at a cost savings of two to two-and-a-half times over outsourcing the parts to a traditional machine shop. Moreover, the bike designers were able to request small design changes and still have the new parts built in time for the TV presentation.

The low-risk approach paid of . The Sharks approved funding, the company built its bike, and the product was shown at the annual Israeli Inventors Conference. ■

*Contributing Editor **Pamela J. Waterman**, DE's simulation expert, is an electrical engineer and freelance technical writer based in Arizona. You can send her e-mail to DE-Editors@deskeng.com.*

FOR MORE INFO:

> Intelitek

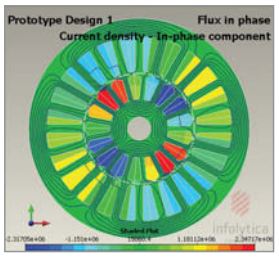
> Solido

> Ziv-Av Engineering LTD.

EDITOR'S PICK OF THE WEEK SHOWCASE

> CLICK HERE FOR THE FULL WRITE-UP AND PREVIOUS EDITOR'S PICK OF THE WEEK.

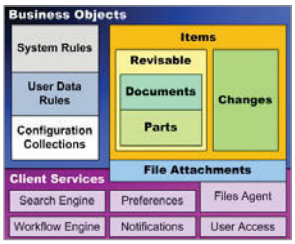
More features means better designs with MotorSolve



MotorSolve v2 is the design software solution for all types of electric machines. The easy-to-use template based interface makes it effortless to design any number of brushless dc, induction and switched reluctance machines. The integrated automated FEA solver accurately calculates all performance parameters. Request a live demonstration with one of our technical representatives today.

> Infolytica Corporation

PDXpert PLM: Easy Product Data Management



PDXpert software offers a simple, flexible and affordable way to manage your design, production and support data. PDXpert PLM features item numbering & revision control; bill of material (BOM) management; file storage with text search; engineering change management (ECN) and workflow for change approvals. PDXpert – perfect solution for growing companies. Call us or visit our website to download a FREE TRIAL now.

PDXpert PLM

> Active Sensing, Inc.

(800) 9-BUY-PLM

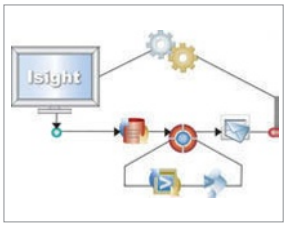
Effortless 3D Scanning from Exact Metrology

The **Artec 3D Scanner** from Exact Metrology is a portable 3D camera that captures video, and each single frame is a three-dimensional image. It works without markers or mounts, and is ideal for a variety of 3D scanning applications including computer graphics & animation, medical imaging, archival and more. Complete systems are available starting around $15,000. For more information please call or visit our website.

> Exact Metrology

(866) 722-2600

Simulation Automation and Design Optimization



Discover Isight and Fiper from **SIMULIA**

> Reduce development time by integrating and automating simulation workflows.

> Improve product quality by exploring multiple design alternatives.

> Lower costs through efficient job distribution and use of existing computing resources.

> SIMULIA

EUROCOM i7 based Mobile Workstations with RAID 5 support

Eurocom Mobile Workstations are designed for engineers who do heavy-duty computing in 3D visualization and professional applications like AEC, BIM, CAD, CAM, CAE, DCC, GIS, and Media Creation. The Eurocom Mobile Workstation is portable, extremely powerful with maximum upgradeability, expandability, and reliability. With unrivaled power, unsurpassed features and unmatched style, Eurocom Mobile Workstations are the ultimate evolution of the Desktop Replacement notebook.

> Eurocom

Océ CS4300 Scanner Series

Get professional scanning results for drawings, renderings, photos and more up to 54" wide with the new **Océ CS4300** Series scanners. Capture the finest detail with 600 dpi optical resolution and optional interpolated resolution up to 9600 dpi. Scan rigid originals up to 15mm thick. Océ Copy Easy software makes it easy to get scans right every time and also upgrades your Océ printer to a full hybrid system.

> Océ

800-714-4427

Verisurf AutoSurface

AutoSurface, a new feature for Verisurf Reverse, lets you create complex shaped surfaces with a single click then output a solid or surface model compatible with your CAD system. 100% automatic, AutoSurface does not require curve network. With Verisurf's reverse engineering software, you perform the entire scanning, meshing, auto-surfacing, solids generation, machining, and inspection process in a single application using one file.

> Verisurf Software

PRODUCT SHOWCASE

>CLICK HERE FOR PRODUCT SHOWCASE INFO

CADRE Pro 6 For Windows/XP/2000

CADRE Pro 6 For Windows Vista/XP/2000 (32 & 64 Bit) with advanced modeling tools including CAD importing. A practical and affordable tool for engineers. CADRE Pro solves mechanical and architectural structures for internal loads, beam section or plate stresses, displacements, vibration modes, and natural frequencies. Advanced features for stability, buckling, shock and seismic loads. Eleven element types including specialized beams and plates.

> CADRE Analytic

425.392.4309

SOLIDS++

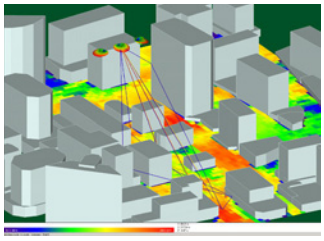
The 3D modeling kernel of the future; is your modeling kernel evolving with your future plans, or stifling your creativity? Need access to the software developers for support?

Choose **SOLIDS++** today for a successful future.

> IntegrityWare

858.592.8866 • Dgill@IntegrityWare.com

Wireless InSite® for Wireless EM Propagation

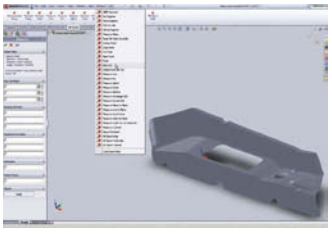


Remcom's Wireless InSite® is site-specific radio propagation software for the analysis and design of wireless communication systems. It provides efficient and accurate predictions of propagation and communication channel characteristics in complex urban, indoor, rural and mixed path environments. Applications range from military defense to commercial communications, including wireless links, antenna coverage optimization, and jammer effectiveness. Visit www.remcom.com/wireless-insite for more information.

> Remcom • 814.861.1299

ReSpect™

***ReSpect*™, the Inspection Software Plug-in from ReverseEngineering.com Integrates PCMM Hardware into SolidWorks**



Current and future owners of inspection hardware devices (PCMMs) have long been asking if they can inspect and measure direct in their SolidWorks software.

ReSpect, a robust inspection plug-in from ReverseEngineering.com does just that. Save hours and days while performing traditional inspection and measurement tasks. Easy to use and native in SolidWorks.

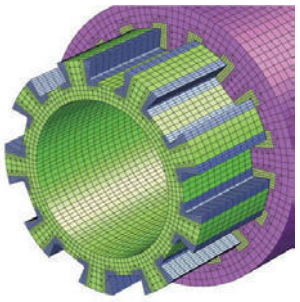
> ReverseEngineering.com

Unique OEM Electronics!

Remarkable test equipment, software, and components with specs or prices you won't find ANYWHERE else: premium quality, economical LCD oscilloscopes, spectrum analyzers, USB and Logic analyzers, engineering software, pure RF sources, DMMs, wireless and wired data loggers, test equipment, touch-sense ICs, Ethernet hard-wired TCP/IP ICs and modules, USB I/O ICs, high-reliability PCs, wireless and I/O control, Ethernet-serial/USB-serial/RS232-485, software, etc. FREE Elektor magazine.

> Saelig • 1.888.7SAELIG • info@saelig.com

Mesh Generator and Pre-Processor for FEA and CFD Analysis



TrueGrid® software creates the ideal mesh for all multi-physics problems.
Build meshes for fluids, structures, and the interface for fluid-structure interaction.
Use TrueGrid® to select controls, loads, contact surfaces, boundary conditions, element types, cross sections, and material properties. TrueGrid® supports over 30 analysis codes, including ABAQUS, ANSYS, LS-DYNA, and NASTRAN.

TrueGrid® by XYZ Scientific Applications, Inc.

> TruGrid®

925.373.0628

ADVERTISER INDEX

DE EDITOR'S PICK OF THE WEEK

DE MARKETPLACE

DE PRODUCT SHOWCASE

DE Desktop Engineering®

Technology for Design Engineering

Flying in the Face of Adversity

PETER COLLINS
dezineforce

In times of economic downturn companies need to prepare themselves to take advantage of the upturn to come, and that means exploring new processes and new solutions. Yet IT budgets are often the first to get slashed when companies start cutting back. For engineering companies, where the quality of IT systems has a direct impact on the design team's ability to deliver innovative products to market on time and on budget, trimming IT can sound the death knell for their ambitions.

When it comes to evaluating new solutions and processes in a difficult economic climate, the overly cautious fall into one of two camps. First, there are the companies that are busy and unwilling to invest time in exploring new approaches; effectively sidelining innovation and long-term company objectives to focus on the next

> It is risky to delay decisions to explore new solutions; the time is now.

quarter's results. The second group are the companies that aren't busy at all. These companies have no excuse for not evaluating new approaches and they should make it a priority to think about new ways to work when they have the time.

We are witnessing a sea change in how companies access software and computing power. More and more companies are tapping into Web-based applications and SaaS (software as a service) portals, assigning computing tasks to remote locations, collectively known as the cloud. While the SaaS model has proved suitable in areas like HR and sales, questions have been raised about its potential in more complex and compute-intensive ares such as engineering design.

The experience of dezineforce has shown that the SaaS model

DE MARKETPLACE

lends itself extremely well to the project-based nature of much design activity, enabling new solution providers to make an impact in the design process. Instant availability means subscribers can immediately focus on designing, rather than wasting time in the definition, procurement, and configuration of commodity technology. Built-in flexibility enables immediate and essentially infinite availability to grow capacity in response to demand.

As we come out of this recession we will face more aggressive competition from companies in countries such as India, Brazil, and China, where companies are increasing their design capabilities all the time. The new generation of SaaS-based design technologies—search and optimization techniques, high-performance computing and workflows, all delivered over the Web—are the cost-effective way to prepare for the economic upturn and fight off competitors from these emerging economies.

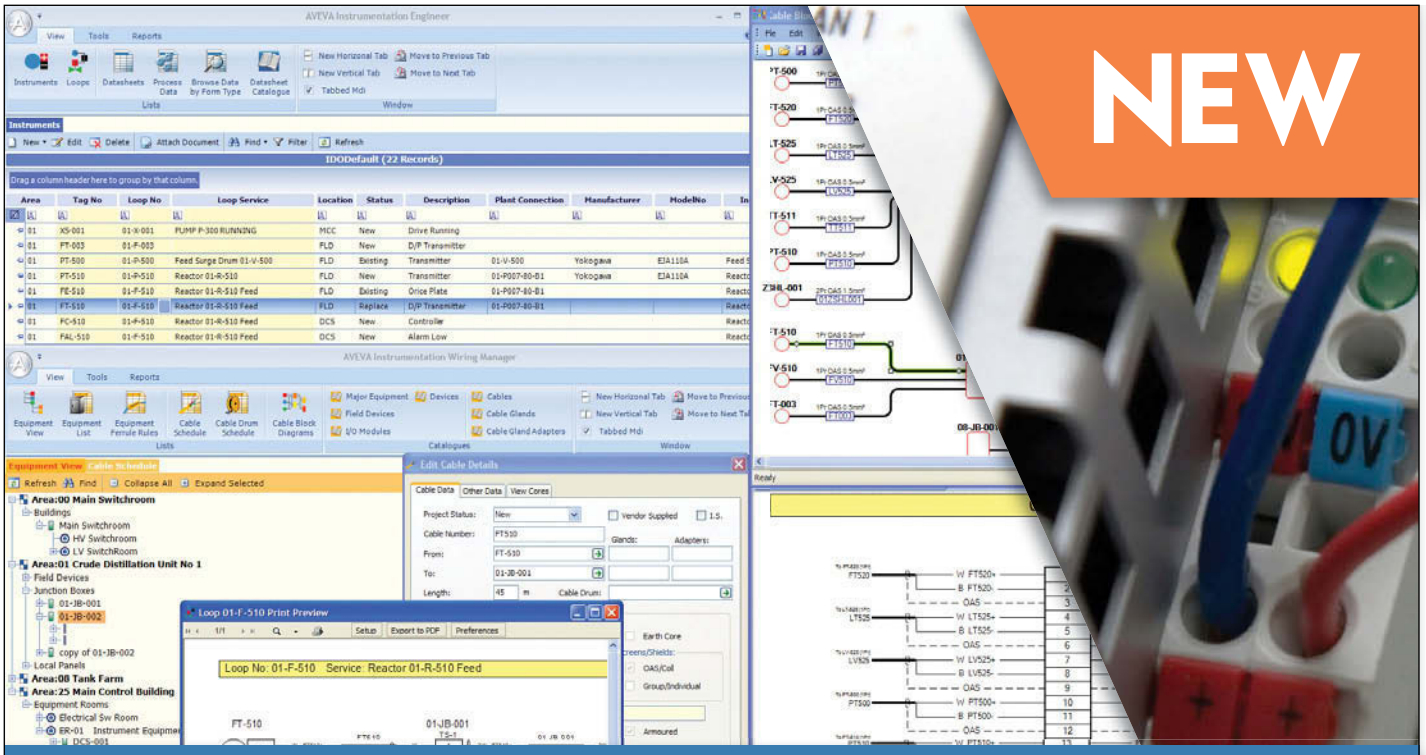
For those out there shrinking away from making decisions, it is time to consider the value of those decisions. For engineering firms the end goal of any evaluation of new solutions or a new approaches should be to make the design process more effective and efficient, and to make the business more agile and able to respond to client needs.

The time to look at new ways of working is in advance of new contract wins, not after the contract is signed. Design companies need to improve their processes now and when those wins come through they can access the new capacity immediately and hit the ground running. For manufacturers this means less time to market; for design houses, greater competitiveness in bidding for design contracts.

Engineering companies can no longer rely on traditional approaches and existing processes as they face competition. SaaS is an enabler for companies trying to work their way out of a slump and it is time to investigate new delivery methods and a new generation of providers dedicated to helping companies raise their design capability to an entirely new level. ■

Engineering companies can no longer rely on traditional approaches and existing processes as they face competition.

***Peter Collins**, Ph.D., is the commercial director and founder of dezineforce. His doctorate is in computational fluid dynamics from Imperial College in London and he has an MBA from INSEAD. Send e-mail about this commentary to DE-Editors@deskeng.com.*



Efficiently design and maintain your instrumentation data with

AVEVA Instrumentation.

You now have a real choice for instrumentation design.

Introducing AVEVA Instrumentation, a feature-rich software suite for instrumentation and control engineering. This complete solution offers an advanced graphical user interface and maximum workflow flexibility with extensive use of design rules and catalogs. Find out why AVEVA Instrumentation is used by leading companies in the plant industries to increase productivity and drive rapid ROI.

AVEVA
CONTINUAL PROGRESSION

AVEVA Inc
10350 Richmond Avenue
Suite 400
Houston, Texas 77042

Tel +1 713 977 1225
sales.us@aveva.com
www.aveva.com

MAKE YOUR IDEAS REAL

dimension 3D Printers

3D PRINTERS

Dimension 1200es Series

THANKS, BOSS!

OUR NEW DIMENSION 3D PRINTER HELPED US RELEASE PROJECT DELTA TO MANUFACTURING 23 DAYS SOONER.

- SEEING/TESTING 3D MODELS DURING DEVELOPMENT REALLY WORKS — A FASTER FINAL DESIGN.
- TOUGH ABS MODELS TEST LIKE THE REAL THING.
- AT ONLY $275/MO* TO LEASE, WE COULD AFFORD ANOTHER DIMENSION 3D PRINTER!
- CHECK OUT: WWW.DIMENSIONPRINTING.COM/DE2

THANKS AGAIN!
— LARRY

HERE'S THE FINAL STRUT PROTOTYPE.
PASSED ALL FUNCTIONAL TESTS!

*Price for US leasing. Additional options, shipping, applicable taxes/duties not included.

STRATASYS